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Commercially Focused Forage Production from Columbus Grass and Centurion Grown Alone or in Mixtures in the Semi Arid Environment

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Abstract: An experiment was conducted to determine the component and summative yields of Columbus grass and Centurion species in Semi arid zone. The treatment combination were seed rate of 30 kg ha^{-1} of *Sorghum almum*, 10 kg ha^{-1} *Centrosema pascuorum* each representing 100% sole pasture and their mixtures in the ratios of 25% *S. almum*: 75% *C. pascuorum*, 50% *S. almum*: 50% *C. pascuorum* and 57% *S. almum*: 25% *C. pascourum* laid out in a complete randomized block design using plot size of 4×2 m. Pasture was sampled to monitor establishment and physiological development from 14 Days Post-Planting (DPP) and thereafter at 2 weeks interval up to full bloom stage. At full bloom stage forage was harvested to determine Dry Matter yield (DM). Results obtained showed stand counts of *Sorghum almum* statistically ($p<0.05$) increased from day 14 and attained a maximum by 56 days. From 42 DPP and subsequently, mixture with 25 or 50% *C. pascourum* had higher ($p<0.05$) stand counts relative to other treatments. Pasture height varied from 25.1-28.5 cm at 14 DPP. Thereafter, from 42 DPP, differences ($p<0.05$) manifested up to 84 DPP amongst the treatments evaluated. The treatment with 25% *C. pascourum* had taller ($p<0.05$) sward stand relative to other factors. Sward grown in mixture were comparable ($p>0.05$) in fresh leaf (75-83%). Dry matter yield was significantly different ($p<0.05$) in both component and cumulative yield. The mixture with 50% *C. pascourum* was statistically superior to all other treatments. Higher ($p<0.05$) total DM yield was obtained with treatment that had 50% *S. almum* plus 50% *C. pascourum*. Cost-benefit analysis of production showed higher output and net benefit from the mixed pasture sward of 50% Columbus grass and 50% Centurion. Based on the results of the present study, commercial pasture production would be more economical from mixed pasture sward of 50% Columbus grass and 50% Centurion in the zone.

Key words: *Sorghum almum*, *Centrosema pascourum*, mixed pasture, commercial pasture production, semi arid zone

INTRODUCTION

Columbus grass (*Sorghum almum* Parodi) is grown mostly in pure stands, but on well drained soils. Mixtures of *Sorghum almum* with legumes produce good pasture. *Sorghum almum* was successful tried in mixture with *Glycine wightii* and twining species of *Vigna*. In Northern Australia, *Sorghum almum* was grown in mixtures with *Stylosanthes humilis*. It did well in the first season but not so well in subsequent years. *S. almum* was tried with *Pueraria phaseoloides* but it was found to be too strong for *Sorghum almum* and smothered it during the establishment period (Bogdan, 1977).

Legumes in mixed swards are assumed to improve the soil condition, produce more herbage than legumes or grasses alone (Becker *et al*., 1998). Grasses grown with legume contain more protein than grass alone unless if heavily fertilized with nitrogen. Mixtures resist weed encroachment; remain productive longer than pure legumes stands and grasses reduce lodging by legumes, thus saving more leaves. Grass-legume mixtures are more easily cured for hay or preserved as silage than pure legumes. Forage yield, nutritive value and animal performance are improved from mixtures of grass legume pasture (Tarawali *et al*., 1998).

Pasture production as a commercial enterprise is not a common practice in developing countries but could be an economically viable venture. Functional Government ranches existed way back since 1914, the African ranches Ltd. (1914-1931) tried the idea of intensive

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sedentary form of livestock production in Northern Nigeria, but to date no encouraging information with regards to commercial pasture production as an economic enterprise. However, due to rapid demographic changes and the growing concern on environment, improved feed availability in the future requires development of composite sown pastures that is to be sustained under intensive systems of management and must be cost-effective. These therefore require the development of sustainable production packages targeting commercial production enterprise. The objective of this study was therefore, to determine the growth, development and relative yield contributions from Columbus grass-Centurion mixed sward for commercial production enterprise in Semi arid zone. It is hoped that the results from this study would provide base line data on the remerging job opportunities for use by policy makers, agricultural based community development agencies, non Governmental organizations and individual livestock farmer.

MATERIALS AND METHODS

Description of experimental location: A 2 years trial was conducted at the Bayero University Farm during the 2006 and repeated by the site in 2007 rainy season. The location of the experiment site was 11°59'N and 8°25'E at an altitude of 460 m above sea level in Semi arid zone of the Nigeria. The soil of the experimental site was loamy-sand, acidic and low in organic carbon with the chemical characteristics shown in Table 1. The climate of the study area is characterized by a defined wet-season, which normally begins in May and end in September. The dry season on the other hand, last from October to April. A rainfall pattern record taken at university weather station is shown in Fig. 1.

The experiment was conducted on a well prepared seed bed following single ploughing and harrowing 2 times. Plot sizes of 4×2 m (8 m^2) were laid out in a Randomized Complete Block Design (RCBD). One meter spacing was provided between treatments plots and 2 m between blocks. The treatment combination were seeds rate of 30 kg ha^{-1} of *Sorghum almum*, 10 kg ha^{-1} *Centrosema pascuorum* each representing 100% sole pasture and their mixtures in the ratios of 25% *S. almum*: 75% *C. pascuorum*, 50% *S. almum*: 50% *C. pascuorum* and 57% *S. almum*: 25% *C. pascuorum*. Each of these treatments was replicated 3 times. Seeds were sown in early July by drilling in rows 50 cm apart. Fertilizer N:P:K 20:10:10 were applied at 60 kg N ha^{-1} to grass and grass-legume mixtures, while 30 kg P ha^{-1} for sole legume plots at 2 weeks post emergence. Two weeks later (i.e., 4 weeks post-planting), 90 kg N ha^{-1} were applied to sole *S. almum* plots. Other weeds and broad leaf annuals were rougued by hand.

Field sampling: Field sampling were done to monitor pasture establishment and physiological development from 14 days post-planting and thereafter at 2 weeks interval up to full bloom stage. Plant counts within a 50×50 cm quadrats $plot^{-1}$ were used to determine plant population ha^{-1}.

Plant height was determined by randomly selecting 5 plants within each quadrat and their heights measured with tape from ground level to the end of the youngest leaf. At full bloom stage, fresh samples were harvested, collected and weighed. From the sample a sub-sample of 100 g fresh were oven-dry for the period of 2 days at 60°C and weighed to determine dry matter yield. Cost of inputs and output based on DM yield were used to compute for net benefit.

Data analysis: Data collected were analyzed using the general linear model of statistical analysis system (SAS, 1999-2000) statistical package. Differences between means were considered significant at 5% level of probability. Net benefit analysis was computed through the use of simple partial farm budget.

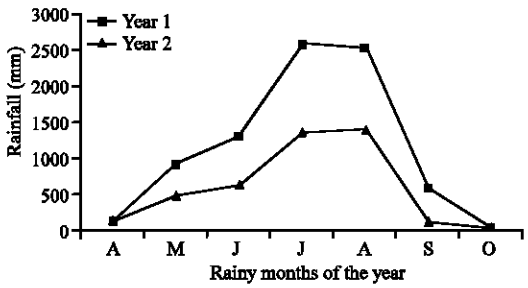

Fig. 1: Rainfall distribution during the experimental periods

Table 1: Organic and mechanical characteristics of soil of the experimental site

Depth (cm)	pH	N (%)	OC (%)	OM (%)	Sand (%)	Clay (%)	Silt (%)	Textural class
0-15	6.26	0.04	0.59	1.03	77	4.2	18.8	Loamy sand
15-30	6.39	0.05	0.58	1.00	79	8.2	12.8	Loamy sand

RESULTS

Stand counts: Table 2 present the stand counts of *Sorghum almum* m^{-2} taken bi-weekly. The data obtained manifested statistical difference ($p<0.05$) between the treatments examined. Stand counts in all treatments increased from 14 days and attained a maximum by 56 days. By 42 DPP and subsequently, mixture of 50% *S. almum* plus 50% *C. pascourum* and 75% *S. almum* plus 25% *C. pascourum* had significantly higher stand counts relative to other treatments examined.

Sward height: Bi-weekly assessment of height (cm) of *Sorghum almum* grown as mixed sward with legume in the Semi arid zone (Table 3) manifested significant difference ($p<0.05$) from 42 DPP. Pasture height varied from 25.1-28.5 cm at 14 days. Thereafter, from 42 DPP significant differences ($p<0.05$) manifested up to 84 DPP amongst the treatments examined. Treatment with different proportion of Centurion had significantly ($p<0.05$) higher sward height compared to sole *Sorghum almum* sward. The treatment with 75% *S. almum* plus 25% *C. pascourum* had significantly taller sward stand relative to other factors examined.

Cumulative dry matter yield: Table 4 presents component and summative yield of the species evaluated. The sampled material had fresh leaf (75-83% freshness). Sward grown in mixture were comparable in fresh leaf but significantly ($p<0.05$) higher compared to sole pasture sward. Dry matter yield manifested significant differences ($p<0.05$) in both component and cumulative dry matter yield of the species evaluated. The mixture of 50% *S. almum* plus 50% *C. pascourum* was statistically superior to all other treatments.

Similarly, there were significant differences ($p<0.05$) in dry matter yield of Centurion between treatments. Treatment with 25% *S. almum* plus75% *C. pascourum* had statistically superior fraction of Centurion relative to the other treatments examined.

The amassed dry matter yield of the species considered differed significant ($p<0.05$). The use of 75-100% *Sorghum almum* to constitute the sward resulted in comparable summative fodder yield. Significant ($p<0.05$) total dry matter yield was obtained with treatment that had of 50% *S. almum* plus 50% *C. pascourum.*

Cost-benefit analysis: Table 5 presents cost-benefit analysis of production of *S. almum* and *C. pascourum* either sole or in mixed pasture swards. The computed unit price of each kg DM of *Sorghum almum* was ₦20.83, while the price of Kg DM of *C. pascourum* was ₦29.16. The highest output of ₦269,536.00 was obtained from the mixed pasture sward of 50% *Sorghum almum* and 50% *C. pascourum*, while the lowest output of ₦99,144.00 was obtained from sole sward pasture of 100% *S. almum*. Total variable cost of production varied slightly between the 4 pasture swards. The highest variable cost of production was obtained from the sole sward pasture where 100% *Sorghum almum* was grown, while the least

Table 2: Stand counts of *S. almum* grown in *S. almum*, *C. pascourum* mixed swards in the semi arid zone

	Days post planting			
Treatments	14	28	42	56
100% *S. almum*	80.00^{ab}	99.30^{b}	120.30^{b}	145.30^{a}
25% *S. almum* 75% C. *pascourum*	45.30^{c}	72.70^{c}	100.00^{c}	100.10^{b}
50% *S. almum* 50% C. *pascourum*	84.00^{a}	98.00^{b}	148.70^{a}	148.90^{a}
75% *S. almum* 25% C. *pascourum*	77.30^{b}	104.70^{a}	145.30^{a}	148.30^{a}
LSD	5.87	6.91	6.06	5.06

Means with different latter superscripts within same column differ significantly ($p<0.05$)

Table 3: Height of *S. almum* in *S. almum-C. pascuorum* mixed swards in the semi arid zone

	Days post planting					
Treatment	14	28	42	56	70	84
100% *S. almum*	27.40	52.80	133.60^{b}	150.20^{b}	154.90^{b}	159.30^{b}
25% *S. almum* 75% *C. pascourum*	27.10	61.70	146.80^{ab}	161.10^{ab}	166.60^{ab}	172.70^{ab}
50% *S. almum* 50% *C. pascourum*	25.40	73.20	159.80^{ab}	175.20^{ab}	181.30^{ab}	188.00^{ab}
75% *S. almum* 25% *C. pascourum*	28.50	63.40	183.80^{a}	201.20^{a}	204.90^{a}	210.30^{a}
LSD	6.27	20.32	43.95	44.90	45.02	44.72

Means with different latter superscripts within same column differ significantly ($p<0.05$)

Table 4: Dry matter yield (DM t ha^{-1}) of *S. almum* and *C. pascuorum* in mixed or sole pasture sward grown in the Semi arid zone

Treatments	*Fresh leaf (%)	*Sorghum almum*	*C. pascuorum*	Cumulative yield
100% Sole species	75.00^{b}	9.70^{c}	3.40^{a}	9.70^{b}
25% *S. almum* 75% *C. pascourum*	81.70^{a}	5.70^{b}	2.00^{b}	9.10^{b}
50% *S. almum* 50% *C. pascourum*	83.30^{a}	10.00^{a}	2.10^{b}	12.50^{a}
75% *S. almum* 25% *C. pascourum*	80.00^{a}	8.60^{c}	0.60^{c}	10.10^{b}
SEM	4.56	2.58	0.62	2.33

Means with different latter superscripts within same column differ significantly ($p<0.05$); * Fresh leaf assessment was for *Sorghum almum* alone

Table 5: Cost-benefit analysis of DM yield (kg ha^{-1}) of sole *S. almum*, *C. pascourum and* in mixed pasture sward in the semi arid zone

Pasture swards	DM yield	Unit price of output (₦ kg^{-1})	Output (₦ ha^{-1})	Total variable cost (₦ ha^{-1})	Net benefit (₦ ha^{-1})
100% Columbus grass (S)	9700	0.17	1683.76	241.66	1442.91
100% *C. pascourum* (C)	3400	0.24	826.20	208.33	617.87
25% S +75% C	7700	0.18	1475.43	216.66	1258.75
50% S +50% C	12100	0.21	2246.13	225.00	2021.13
75% S +25% C	9200	0.18	1638.60	233.33	1405.28

Cost was computed using the exchange rate of ₦120-£1

was obtained from sole sward pasture with 100% *C. pascourum*. The variable cost of production and the net benefit obtained from the pasture sward varied from the sole sward pasture of 100% *Sorghum almum* and the mixed pasture sward of 50% *Sorghum almum* and 50% *C. pascourum*, respectively.

DISCUSSION

Grasses are more bulky and contribute to the bulk of feed material, while legume improves the quality of herbage. Pasture growth and development are some of the agronomic indices for pasture yield assessment/ unit area. Pasture stand count and height were yield components obtained, which concur with data reported by Kallah *et al*. (1999) and Muhammad *et al*. (2006).

Percent fresh leaf obtained was greater than the leafiness (18-30%) reported by Muhammad *et al*. (2002a) from sub humid zone of Nigeria. It is important to reiterate that fresh leaf reported in the present study was for fresh material and not relative leaf proportion as reported by Muhammad *et al*. (2002a). This nevertheless, it further suggests that the fodder harvested could be high in nutritive value as reported earlier (Muhammad *et al*., 2002a; Lanyasunya *et al*., 2006).

Yields data obtained from both pure *S. almum* and mixed swards are all within the range (5.4-19.4 DM t ha^{-1}) reported by several authors (Bogdan, 1977; Kallah *et al*., 1999; Muhammad *et al*., 2002a, 2006). Contrary, the yields of pure *Centrosema pascuorum* obtained in this study was below the data reported by Muhammad *et al*. (2002b).

Pasture yield ha^{-1} account for indices of cost and benefit. Data obtained from the present study did not reveal much difference in the total variable cost of production of the 4 pasture swards. Comparison of the variable cost of production ha^{-1} with the output obtained ha^{-1} for all the 4 pasture swards showed wide differences.

Data expressed that with ₦2500 variable cost ha^{-1}, as much as ₦99,144.00 ha^{-1} of output is obtainable from 100% sole pasture sward of Columbus grass. However, mixed pasture sward of 50% Columbus grass and 50% Centurion resulted higher net benefit compared to other pasture swards examined.

CONCLUSION

The data therefore, suggested that mixed sward pasture of 50% Columbus grass and 50% Centurion would grow and yield for profitable enterprise in the semi arid zone.

This study has provided base line data on an remerging job opportunity for use by policy makers, community based agricultural development agencies, agricultural based non governmental organizations and individual livestock farmers.

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