EFFECT OF STAGE OF GROWTH ON YIELD COMPONENTS OF TWO TEMPERATE AND TROPICAL FORAGE LEGUMES IN JOS, NIGERIA

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ABSTRACT

A study was conducted to determine the yield components of Red clover (*Trifolium pratense*), White clover (*Trfoilium repens*), Cook Stylo (*Stylosanthes guainensis*) and centrosema (*Centrosema molle*) forage legumes at different stages of growth in Jos, Nigeria. The experiment was arranged in 4 x4 Latin Square Design with four replicates. Yield components were measured at 3, 6, 9, 12 and 15 weeks after sowing (WAS). The result showed that plant height was higher ($P<0.05$) in *C. molle* at all growth stages attaining 147.75 cm at 15WAS while *T. pratense* had the lowest value of 61.75 cm in 2016 cropping season. Leaf number was higher ($P<0.05$) in *S. guainensis* (132) in 2015 while *T. repens* had higher value of 221 at 15WAS in 2016 cropping season. There was decrease in leaf to stem ratio in all the treatments at all stages of growth measured. Soil cover was higher ($P<0.05$) in *S.guianensis*, reaching about 100% at 12 WAS in 2015 cropping season while *T. repens* had the highest value of 98% in 2016 cropping season at 15 WAS. It is therefore, concluded that the tropical forage legumes have the potential to accumulate more dry matter than the temperate forage legume species in Jos, Nigeria.

Keywords: Yield, components, legumes, forage, stage, growth.

INTRODUCTION

Ruminant animal production in Nigeria is known to be generally characterized by poor quality feeds resulting to low productivity. Generally, forages that are adapted to tropical climate are known to have higher lignin and cellulose contents compared to the forages of the temperate regions. Nutrients content and digestibility are found to be higher in temperate legumes and C3 grasses as compared to legumes in tropical climates and C4 grasses, respectively (Archimède *et al.*, 2011). Red clover (*Trifolium pratense* L) and White clover (*T. repens* L), are forage legumes widely grown in the temperate regions of the world for livestock feeding. The two legumes provide forages that are high in protein content and digestibility which facilitates high feed intake by animals. Stylo (*Stylosanthes guianensis* Cv. Cook) is one of the forage legumes well suited to the sub-humid tropical and sub-tropical climates with a marked dry season (Heuzé *et al.*, 2015). Centrosema (*Centrosema molle* Mart. ex Benth.) is a forage legume grown in the wet tropics and is one of the palatable legumes. Jos is located on a high altitude with a cool climatic condition which can enable temperate crop varieties and animal breeds to thrive. Presently, only tropical forages are cultivated in Jos. The aim of the study was therefore to evaluate the effect of stage of growth on yield components of the four forage legumes in Jos, Nigeria.

MATERIALS AND METHODS

***Location of the study*:** The experiment was carried out at the Nigerian Institute forTrypanosomiasis Research (NITR), Vom, Jos, Nigeria. Average weather conditions obtained from the Potato Programme of the National Root Crops Research Institute Kuru, Jos showed that highest maximum temperature (32^{O}C) was in March while relative humidity (84%) and rainfall (401.1mm) were highest in the month of August. Average rainfall were 15.1 and 327.7mm in the month of June during 2015 and 2016 season, respectively. The analyses of soil physical and chemical properties of the experimental area showed that the soil is Sandy-clay and loam with a pH of 5.60, low in Nitrogen (0.33%) and Phosphorus (7.53mg/litre).

Land preparation and experimental design: The land was ploughed and harrowed with locally made hoes. The field was levelled and all debris and weeds removed to provide clean seedbeds. Four treatments (*T. pratense, T. repens, S. guianensis and C. Molle*) of the forage legumes were used and each treatment was replicated four times in a 4X4 Latin Square arrangement. The size of the plots were 5 X 3m each while the total land area was 24 X 15m. The space between the plots was

1m and 0.5m along the column and row, respectively.

Pasture establishment: Seeds of two temperate forage legume, Red clover (*Trifolium pratense* L), AberClaret variety and White clover (*Trifolium repens* L), AberHerald variety were obtained from IBERS, Aberystwyth University, United Kingdom, while two tropical forage legume seeds, Cook Stylo *(Stylosanthes guianensis*) and Centro (*Centrosema molle*) were obtained from the Feeds and Nutrition Research Programme of the National Animal Production Research Institute, Shika, Zaria, Kaduna State, Nigeria. This trial was conducted in the 2015 and 2016 starting from June each year. The recommended seed rate of 7.5kg and 6kg for *T. pratense*, and *T. repens*, 6kg and 5kg for *S. guianensis* and *C. molle*, respectively were used. The seeds of *S. guianensis* and *C. molle* were scarified by immersing in hot water before planting. The seeds were planted at the recommended row spacing of 0.3m for *T.pratense, T. repens* and *S. guianensis*, while for *C. molle*, it was 0.5m. Recommended sowing depth of 5-10mm was used for *T. pratense* and *T. repens* while the depth for *S. guianensis* and *C. molle* were 1 and 2.5cm, respectively. Prior to planting, Single Superphosphate fertiliser (18% P_2O_5) was applied at a rate of 30 kg ha^{-1}. In 2016, poultry manure was applied at the rate of 6 t ha^{-1}.The plots were hand weeded using locally made hoes.

Yield components and soil cover estimation: Five (5) plants in the middle of a row of each plot were tagged and used to determine yield components at 3, 6, 9, 12 and 15 WAS. The height of the tagged plants were measured using graduated meter rule. The number of leaves and branches were counted. The length and width of the middle leaflets were measured using five trifoliate, from where the middle leaflets area was calculated. Three plants within a row in each plot were harvested to determine leaf to stem ratio by seperating the leaves of the harvested plants from stem with petiole, weighed immediately and oven-dried at a temperature of 65 to 70°C for 24 hours, the dry weights were used to determine leaf to stem ratio. Soil cover was estimated using the method of Tarawali *et al.* (1995).

Statistical Analyses: The data generated were subjected to analysis of variance (ANOVA) procedure of SAS (2001). Means that were significantly different were separated using Tukey test.

RESULTS AND DISCUSSION

Plant height, number of branches and soil cover at different stages of growth are shown in Table 1. The plant height was higher ($P<0.05$) in *C. molle* at all the stages of growth in the 2 years. The plant height of *T. pratense* obtained in this study at 15 WAS fall within the range of 50 to 70cm but lower than 64 cm reported by Tucak *et al.* (2013) and Asci (2011), respectively across six countries in Europe. The plant height at 12WAS of *S. guianensis* was lower than 135cm reported by Kiyothong *et al.* (2005) in Indonesia. Forage legumes have not started branching at 3WAS as they were still at the establishment stage therefore, no records could be taken. The number of branches for *S. guainensis* (17.25) was higher ($P<0.05$) in 2015 while *T. repens* (30.5) was higher in 2016. The number of branches for *C. molle* in this study at 15WAS was higher than 3.3 reported by Omokanye (2001). Soil cover was higher ($P<0.05$) in *S.guianensis*, reaching about 100% at 12 WAS in 2015, while *T. repens* had the highest value of 98% in 2016 at 15 WAS. Table 2 shows number of leaves, middle leaflet area and leaf to stem ratio. Number of leaves per plant was higher ($P<0.05$) in *S. guianensis* (132) in 2015 while *T. repens* (221) was higher in 2016 at 15WAS. The average number of leaves per plant was however, not significant ($P>0.05$) between *T. repens* (113) and *S. guianensis* (106) but were higher ($P<0.05$) than *C. molle* (71.5) and *T. pratense* (42.64). Middle leaflet area was higher ($P<0.05$) in *C. molle* at all the stages of growth followed by *T. pratense* in the 2 years. Leaf to stem ratio was generally higher ($P<0.05$) in *C. molle* during the 2 years at the various stages of growth followed by *S. guainensis* while *T. repens* had lowest values. Leaf to stem ratio of *T. pretense* obtained in this study fall within the range of 0.76 to 1.03 reported by Tucak *et al.* (2013) while Leaf to stem ratio at 12WAS of *S. guianensis* were lower than 1.5 reported by Nworgu and Ajayi (2005) at Ibadan. The decrease in leaf to stem ratio from 3 to 15 WAS observed in the forage legumes agreed with Ramírez *at al.* (2008) who stated that leaf to stem ratio decrease as plant matures. The different in yield components between the forage legumes may be due to genetic diversity of materials, planting density and spacing, ploidy, the reaction of the studied materials to climate and soil conditions of an area (Tucak *et al.*, 2013). Higher yield components in 2016 season can be attributed to additional poultry manure used which might have added all nutrients in the soil for plant growth and better rainfall pattern in the month of June. *Arthracnose*, a fungal disease

attacked *S. guainensis* and that accounted for the lower values of yield components in the 2016.

CONCLUSION

Yield components of the temperate legumes are generally similar to those in Europe. However, the tropical forage legumes have the potential to accumulate more dry matter than the temperate forage legume species in this cool tropical environment of Jos, Nigeria. *Stysanthes guainensis* is prone to *arthracnose* attack in this environment, and therefore should not be planted as sole crop.

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Table 1: Effect of growth stage on plant height, number of branches/plant and soil cover of the forage legumes for 2015 and 2016 season.

Yield components		(weeks after sowing)														
	Forage-	3			6			9			12			15		
	legumes	2015	2016	Av.	2015	2016	Av.	2015	2016	Av.	2015	2016	Av.	2015	2016	Av.
Plant height(cm)	*T. pretense*	6.13^{b}	7.95^{b}	7.04^{b}	16.25^{a}	19.40^{ab}	17.85^{a}	28.63^{b}	35.63^{b}	32.13^{b}	33.33^{c}	40.00^{c}	36.66^{c}	37.60^{c}	61.75^{c}	49.67^{c}
	T. repens	4.18^{c}	5.57^{c}	4.86^{d}	8.00^{b}	17.50^{b}	12.75^{b}	13.03^{c}	20.75^{d}	16.89^{c}	13.30^{d}	63.00^{b}	38.15^{c}	13.70^{d}	83.00^{b}	48.37^{c}
	S. guianensis	4.75^{c}	5.55^{c}	5.15^{c}	18.00^{a}	18.50^{ab}	18.85^{a}	35.22^{b}	26.00^{c}	30.61^{b}	57.25^{b}	30.00^{d}	43.62^{b}	86.00^{b}	79.00^{b}	82.50^{b}
	C. molle	8.88^{a}	9.12^{a}	9.00^{a}	20.25^{a}	20.75^{a}	20.50^{a}	52.62^{a}	70.25^{a}	62.43^{a}	80.00^{a}	95.25^{a}	87.62^{a}	135.00^{a}	147.75^{a}	143.37^{a}
	SEM	0.37	0.56	0.46	2.93	1.30	2.11	1.64	0.94	1.29	1.99	2.83	2.41	4.45	2.06	3.25
Branches no./plant	*T. pretense*	na	na	na	1.25	1.75^{b}	1.50^{b}	4.25^{b}	4.00^{b}	2.50^{c}	5.25^{b}	5.50^{c}	3.25^{c}	5.25^{b}	14.00^{c}	9.62^{c}
	T. repens	na	na	na	1.25	3.75^{a}	2.50^{a}	1.25^{d}	13.21^{a}	7.22^{a}	1.25^{d}	20.50^{a}	10.87^{a}	1.25^{c}	30.50^{a}	15.87^{a}
	S. guianensis	na	na	na	1.75	1.50^{b}	1.62^{b}	5.25^{a}	2.00^{c}	3.62^{b}	7.00^{a}	3.00^{d}	5.00^{b}	17.25^{a}	8.00^{d}	12.62^{b}
	C. molle	na	na	na	1.50	1.50^{b}	1.50^{b}	2.00^{c}	4.25^{b}	3.12^{bc}	3.50^{c}	8.85^{b}	6.17^{b}	5.00^{c}	18.50^{b}	11.75^{b}
	SEM	na	na	na	0.66	0.35	0.50	0.19	0.61	0.49	0.55	1.07	0.81	0.07	1.27	0.67
Soil cover (%)	*T. pretense*	29.00^{a}	33.40^{a}	32.20^{a}	44.25^{a}	48.75^{b}	46.50^{b}	68.75^{b}	73.50^{a}	71.12^{a}	74.50^{b}	82.25^{b}	78.37^{a}	75.75^{c}	96.75^{b}	86.25^{a}
	T. repens	18.25^{c}	22.50^{c}	20.37^{c}	34.25^{b}	68.25^{a}	51.25^{a}	2.50^{d}	75.75^{a}	39.12^{d}	32.50^{d}	93.50^{a}	63.00^{b}	32.50^{d}	98.00^{a}	65.25^{b}
	S. guianensis	23.75^{b}	24.54^{b}	24.14^{b}	45.50^{a}	48.75^{b}	47.12^{b}	77.25^{a}	34.75^{c}	56.00^{b}	100.00^{a}	32.50^{d}	66.25^{b}	100.00^{a}	55.25^{d}	77.62^{b}
	C. molle	30.00^{a}	32.40^{a}	31.20^{a}	35.25^{b}	38.25^{c}	36.75^{c}	40.75^{c}	56.50^{b}	48.65^{c}	62.50^{c}	66.75^{c}	64.62^{b}	83.25^{b}	89.75^{c}	86.50^{a}
	SEM	1.93	0.91	1.42	4.37	0.15	2.26	2.20	3.06	2.63	1.95	2.26	2.10	2.37	0.83	1.60

Means with different superscripts within a column for a particular parameter are significantly different ($P<0.05$), SEM= standard error of means, na=no data available

Table 2: Effect of stage of growth on leaf number/plant, centre leaf area (CLA) and leaf to ratio of the forage legumes for 2015 and 2016 cropping season.

Yield components	Forage-legumes	(weeks after sowing) 3			6			9			12			15		
		2015	2016	Av.	2015	2016	Av.	2015	2016	Av.	2015	2016	Av.	2015	2016	Av.
Leaves no./plant	*T. pretense*	3.25^{b}	3.50^{b}	3.32^{b}	4.75^{c}	8.25^{b}	6.50^{b}	11.50^{b}	18.62^{b}	15.06^{b}	26.25^{b}	31.75^{b}	29.00^{b}	29.25^{bc}	80.25^{c}	42.64^{c}
	T. repens	3.75^{a}	4.75^{a}	4.25^{a}	4.25^{c}	11.00^{a}	6.12^{b}	5.25^{c}	60.75^{a}	33.00^{a}	5.00^{d}	131.50a	68.25^{a}	5.03^{c}	221.25^{a}	113.02^{a}
	S. guianensis	3.50^{ab}	3.75^{b}	3.62^{b}	8.25^{a}	8.33^{b}	8.29^{a}	23.00^{a}	7.50^{d}	15.25^{b}	47.00^{a}	8.00^{d}	13.75^{c}	132.75a	80.25^{c}	106.51^{a}
	C. molle	2.75^{c}	3.25^{b}	3.00^{c}	6.50^{b}	6.40^{c}	6.45^{b}	10.62^{b}	12.10^{c}	11.33^{b}	14.00^{c}	22.75^{c}	18.37^{c}	34.75^{b}	108.25^{b}	71.51^{b}
	SEM	0.13	0.24	0.18	0.66	0.88	0.77	4.57	2.82	3.69	2.01	3.61	2.81	12.09	3.71	7.90
MLA (cm^2)	*T. pretense*	1.52^{b}	1.08^{b}	1.30^{b}	4.07^{b}	4.52^{c}	4.29^{b}	11.25^{b}	9.99^{b}	10.62^{b}	15.39^{b}	18.95^{b}	17.17^{b}	9.52^{b}	19.81^{b}	14.66^{b}
	T. repens	0.52^{c}	0.22^{c}	0.37^{d}	0.47^{c}	0.63^{d}	0.55^{c}	1.29^{d}	3.05^{c}	2.17^{d}	1.29^{d}	3.35^{c}	2.32^{c}	1.29^{d}	3.48^{d}	2.38^{d}
	S. guianensis	1.60^{b}	0.45^{c}	1.02^{c}	3.32^{b}	4.79^{b}	4.05^{b}	6.29^{c}	4.30^{c}	5.29^{c}	6.32^{c}	4.82^{c}	5.57^{c}	5.90^{c}	9.36^{c}	7.63^{c}
	C. molle	3.75^{a}	2.30^{a}	3.02^{a}	23.34^{a}	23.80^{a}	23.57^{a}	28.18^{a}	35.23^{a}	31.70^{a}	31.85^{a}	40.17^{a}	36.01^{a}	31.87^{a}	40.05^{a}	35.96^{a}
Leaf:stem	*T. pretense*	1.51^{d}	1.50^{c}	3.01^{b}	1.16^{c}	1.17^{b}	1.16^{b}	0.85^{d}	0.99^{c}	0.92^{c}	0.77^{b}	0.89^{c}	0.83^{c}	0.63^{c}	0.48^{b}	0.73^{b}
	T. repens	2.00^{c}	1.99^{c}	1.99^{d}	1.03^{d}	1.03^{c}	1.03^{b}	1.03^{c}	0.69^{d}	0.86^{c}	0.71^{c}	0.58^{d}	0.64^{d}	0.72^{b}	0.47^{b}	0.59^{c}
	S. guianensis	3.01^{b}	2.92^{b}	2.96^{c}	2.07^{b}	1.93^{a}	2.01^{a}	1.19^{b}	1.84^{a}	1.51^{a}	0.72^{c}	1.58^{a}	1.15^{b}	0.56^{d}	0.48^{b}	0.52^{d}
	C. molle	4.00^{a}	3.73^{a}	3.68^{a}	2.22^{a}	1.95^{a}	2.08^{a}	1.45^{a}	1.49^{b}	1.47^{b}	1.05^{a}	1.29^{b}	2.34^{a}	0.96^{a}	0.79^{a}	0.87^{a}
	SEM	0.15	0.41	0.28	0.02	0.14	0.08	0.02	0.09	0.05	0.01	0.04	0.02	0.016	0.014	0.015

CLA= centre leaf area, means with different superscripts within a column for a particular parameter are significantly different ($P<0.05$), SEM= standard error of means, na=no data available.