Effects of Stages of Growth on Dry Matter Yield and Nutrient Composition of Red Clover in the Year of Establishment in Jos, Plateau State, Nigeria

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The XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) takes place virtually from October 25 through October 29, 2021.

Proceedings edited by the National Organizing Committee of 2021 IGC/IRC Congress

Published by the Kenya Agricultural and Livestock Research Organization

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Key words: Nutrient composition; *Trifolium pratense*; Yield; Weeks after sowing; maturity stage

Abstract
An experiment was conducted in Jos, Nigeria to evaluate the effects of stages of growth on dry matter yield and nutrient composition of Red clover (*Trifolium pratense* var. AberClaret) in the year of establishment. The treatments were five (5) stages of growth (5, 9, 13, 17 and 21) weeks after sowing (WAS). The five stages of growth were replicated five times in a Latin Square Design. The land was divided into twenty five plots of 3 m X 3 m each. The spacing between each plot was 1m along the rows and columns. Growth components and DM yield were measured at the various stages of growth. The forage crop was also analysed for nutrients composition. Theere was no significant difference in plant height at 17 WAS (63.75 cm) and 21 WAS (64.25 cm). However, the two stages were higher ($P<0.01$) compared to the other stages of growth. Leaf-to-stem ratio decreased significantly from 5WAS (1.16) to 21WAS (0.26). Forage DM yield was higher ($P<0.01$) at 17 WAS (3.15 t ha^{-1}) compared to the other stages of growth. Crude protein content at 9 WAS (20.88 %) was higher ($P<0.01$) compared to the other stages, while 21 WAS had the lowest value of 18.11 %. Crude protein (CP) content at 9WAS (208.8 g/kg) was higher ($P<0.01$) compared with the other stages as 21 WAS had the lowest value of 181.1 g/kg. Crude protein content decreased from 9 to 21 WAS, while the fibre fractions increased from 9 to 21WAS. Therefore, it is recommended that the legume planted in early June on the Jos Plateau, Nigeria could be harvested at 17 WAS when the DMY is maximum and CP content is also very high to meet the requirements for ruminant animals in the tropics.

Introduction
Red clover (*Trifolium pratense* L) is a perennial forage legume widely grown in the temperate regions of the as well as in the sub-tropical areas of the world for extensive livestock feeding. The legume provides forage with high protein content and digestibility, which facilitates feed intake by ruminants (Black *et al*. 2010). According to Zemenchik *et al*. (2002), the legume usually has higher crude protein content, lower acid detergent fibre and neutral detergent fiber compared with grasses. Different locations have been found to influence the yield and quality of forage crops, but the stage of growth at which a forage crop is harvested for livestock feeding is also important when the overall forage yield and quality are considered. As forage crops mature, the dry matter content increases, but digestibility of neutral detergent fibre (NDF), starch, sugar and crude protein contents are all reduced (Kilcer *et al*., 2003). Therefore, there should be a growth/maturity stage to harvest in order to obtain optimum dry matter yield and quality in different environments. It has become important to evaluate forage yield and quality of Red clover (*Trifolium pratense* L.) at different stages of growth to determine the stage of growth for which the forage crop could be harvested for livestock feeding either as pasture, hay or silage. Jos is located on high altitude (1,223 m above sea level) that has the environmental conditions suitable for adaptation and production of temperate forage crops. Other temperate food crops such as Irish potato and strawberry are produced in the area in commercial quantities. The study was therefore designed to examine the effect of stages of growth on dry matter yield and nutrient compositions of *Trifolium pratense* in Vom, Plateau State, Nigeria.

Methods and Study Site
Location of the Study: The experiment was carried out at the Nigerian Institute for Trypanosomiasis Research (NITR), Vom, (Lat 9.7376°N, Long 8.7914° E and 1,223m above sea level) (Ovimaps, 2014), Jos, Nigeria. The area is characterised by two major seasons (rainy and dry). The rainy season is from May - October and dry season from November - April. Temperatures range from 15 to 27°C during the rainy season and 7 to 32°C during the dry season. Grasses found on this highland are shorter and the trees are fewer than in low altitudes. The soil is classified as sandy-clay loam, generally sticky when wet, has low fertility, quickly becomes hard when there is no rain for 2 to 3 days and cracks easily (Aregheore, 2009). It is low in total nitrogen (0.33%), phosphorus (7.53 mg/litre), but fair in potassium (247.2 mg/litre).

***Land Preparation and Experimental Design*:** The land was disc ploughed once and harrowed twice using a tractor. The field was levelled and all debris were removed to provide a clean seedbed. Five (5) stages of growth (5, 9, 13, 17 and 21 weeks after sowing) were the treatments arranged in a Latin Square Design and peplicated five times. The land was divided into twenty five plots of 3 m X 3 m each. The spacing between each plot was 1 m along the rows and columns, respectively. Growth components and dry matter (DM) yield were measured at the various stages of growth.

***Pasture Establishment and Yield Measurements*:**The trial was conducted when the rains were well established in the first week of June, 2016. Seed rate was 7.5 kg/ha and other recommended agronomic practices of Frater (2013) were used. Prior to planting, Single Superphosphate (SSP) fertiliser (18% P_2O_5) was applied at the rate of 30 kg ha^{-1}. The plots were manually weeded. Ten (10) plants in the middle of the 5^{th} row of each plot were tagged and used to determine the growth components (plant height, number of leaves and number of branches per plant at each stage of growth). Five plants within a row in each plot were harvested to determine leaf: stem ratio by separating the leaves of the harvested plants from the stem. The leaves and the stem were wighed in the field immediately after separation, and were thereafter oven-dried at a temperature of 65^oC for 48 hours until a constant weight was attained. The leaf dry weight was divided by the stem dry weight to determine leaf-to-stem ratio. Forage dry matter was estimated by harvesting plants in the 6^{th} row of each at each stage of growth. The cut forage samples were weighed immediately after harvest to determine fresh weight after which sub-samples were oven dried at 65^oC for 48 hrs. Dry matter yield (DMY) was estimated from the dried sub-samples.

Samples and Data Analyses: Dried forage samples were ground with Thomas Willey Laboratory Miller. Proximate analysis and mineral composition were determined using the method of AOAC (1990), while the detergent fibre analysis was carried out using the method of Van Soest (1991). All data generated were subjected to analysis of variance (ANOVA) test. The General Linear Model of SAS (2002) was used for the analyses and means were compared using Tukey's test.

Results

The result of growth components and dry matter yield is presented in Table 1. There was no significant difference ($P>0.05$) observed at 17 and 21 WAS in plant height, but the two stages of growth were higher ($P<0.01$) compared with the other stages of growth. Leaf-to-stem ratio decreased from 5 to 21 WAS. Number of leaves and branches per plant were significantly higher at 17 WAS than at the other stages of growth. Consequently, the legume had greater ($P<0.01$) accumulation of DM at the 17^{th} week after sowing (3.15 t/ha) as shown in Figure 1. Table 2 shows the nutrient contents of the forage crop as influenced by stage of growth. Crude protein decreased ($P<0.01$) from 5 to 21 WAS. Similarly, the ash content decreased ($P<0.01$) slightly within the same period of growth. On the other hand, the fibre content increased ($P<0.01$) from 5 to 21 weeks after sowing. The mineral contents evaluated were also higher ($P<0.01$) at earlier the stage of growth, but decreased at the later stages, up to 21 weeks after sowing.

Table 1: Growth components of *Trifolium pratense* at different stages of growth

	Weeks after sowing					
Parameter	5	9	13	17	21	SEM
Plant height (cm)	17.0^{d}	33.5^{c}	42.6^{b}	63.8^{a}	64.3^{a}	0.75
Number of leaves per plant	6.0^{c}	16.0^{c}	37.0^{c}	76.8^{a}	63.3^{b}	0.73
Number of branches per plant	2.7^{d}	3.8^{c}	5.5^{b}	6.8^{a}	7.0^{a}	1.73
Leaf to stem ratio	1.2^{a}	0.9^{b}	0.6^{c}	0.4^{d}	0.3^{e}	0.16

^{abcd}means with different superscripts on the same row are significantly different

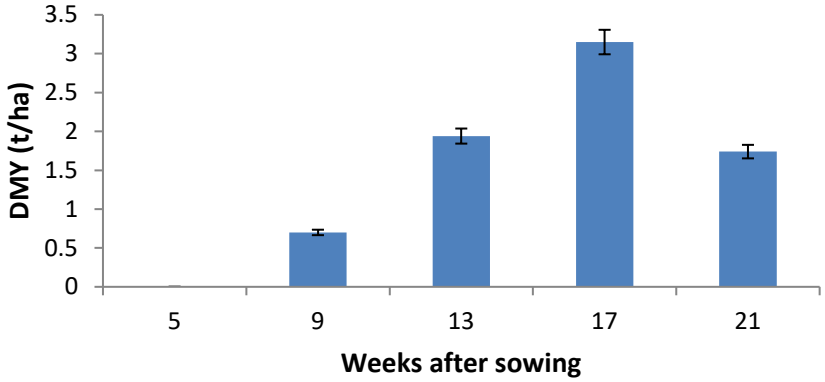

Fig.1: Forage dry matter yield of *T. pratense* at different stages of growth

Table 2: Effect of different stages of growth on nutrient composition of *Trifolium pratense* (g/kg)

	Stages of growth				
Parameter	9 WAS	13 WAS	17 WAS	21 WAS	SEM
Crude protein	208.8^{a}	195.9^{b}	188.3^{c}	180.1^{d}	1.2
ash	118.0^{a}	113.7^{a}	100.1^{b}	96.0^{b}	5.0
Neutral detergent fibre	341.2^{d}	368.3^{c}	399.8^{b}	435.2^{a}	1.6
Acid detergent fibre	234.7^{d}	247.0^{c}	262.4^{b}	282.7^{a}	2.3
Calcium	18.3^{a}	18.1^{b}	17.87^{c}	17.5^{d}	0.4
Phosphorus	3.7^{a}	3.3^{b}	2.54^{c}	2.4^{c}	1.5
Magnesium	5.2^{a}	4.1^{b}	3.90^{c}	3.5^{d}	0.4
Potassium	20.2^{a}	19.2^{b}	18.63^{c}	18.7^{d}	0.4
Sodium	1.6^{a}	1.1^{b}	0.81^{c}	0.2^{d}	0.2

^{abcd}means with different superscripts on the same row are significantly different, WAS= weeks after sowing

Discussion [Conclusions/Implications]

The forage DM yields at different stages of growth in this study were lower than the results obtained in the temperate regions of the world. The lower yields observed in this study could be attributed to genotype and environmental differences. Higher number of leaves at 17 WAS could have led to the higher dry matter accumulation at this stage compared with the other stages. At 21 WAS, there was leaf senescence and detachment from individual plants leading to less DMY as dry season sets in. Dry matter yield was not estimated at 5 WAS as the forage crop was at the early stage of growth and it was too early to harvest. The decrease in CP, ash and increase in neutral detergent fibre and acid detergent fibre from 9 to 21 WAS corroborated with the report of Marković *et al*. (2008) and Newman *et al*. (2006). The authors reported that as plant growth advances, there is greater accumulation of cellulose and lignin in the stem, while the content of CP decreases as lignin is the main chemical deposited internally in the plant cell walls. This study shows that *T. pratense* has the potential to be used as a livestock feed, especially during the dry season as supplementary feed in this cool tropical climate of Jos, Nigeria due to its high CP and ash contents. The forage legume will no doubt meet the CP range of 7 to 16% required by small ruminants for growth and production as stated by (Rashid, 2008). The CP range of 7 to 14% required by cows and 10.5 to 14% for replacement heifers and steers (Kubkomawa, 2015) could be met if animals are fed the legume forage as a protein source. The forage legumes grown in early June in Jos could be harvested around 17 WAS. However, more study involving various planting dates, mixture with grasses, digestibility, etc of the plant in this area should be investigated.

Acknowledgements

Tertiary Education Trust Fund (TETFund), Nigeria supported this project financially. We are grateful to the Institute of Environmental, Biological and Rural Sciences (IBERS), Aberystwyth University, United Kingdom for providing the legume seeds.

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