Botanical Composition, Dry Matter Yield, and Soil Physio-Chemical Properties of Natural Grazing Areas under Sedentary Pastoral System at Different Seasons in South-West Nigeria

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ABSTRACT

This research was carried out to evaluate the botanical composition, dry matter yield, and soil physic-chemical properties of natural grazing areas at different seasons in south-west Nigeria. The experiment was arranged in a 4 x 6 factorial experiment in a Randomized Complete Block Design comprises of four seasons (early rainy, late rainy, early dry, and late dry) in six locations (Awela, Isa-ope, Iwo, Otan, Aagba and Alaaga). Results obtained showed the forages harvested in early rainy season had the highest botanical composition and dry matter yield than other seasons while the soil from Aagba village having the highest pH (8.30) and the soil in late rainy season recorded the highest pH (6.79). The soil in early rain season had the highest value of Nitrogen (0.17%) and Organic Carbon (1.88%) while the soil in late dry season recorded the highest ($p<0.05$) value of Phosphorus (18.19 mg/kg).

(Keywords: natural pasture, location, season, forage quality, range land, feed resources)

INTRODUCTION

Natural pastures are the most important feed resources for ruminant livestock and a basic shortcoming of natural pastures as a source of feed for ruminant livestock is their low production of dry matter due to a combination of the negative effects of inadequate rainfall and the dearth of available soil nitrogen on plant growth (Russell, 1966; Wigg *et al.,* 1973).

The seasonality of plant growth, which is a reflection of the annual rainfall distribution pattern, further restricts the availability of herbage for the grazing animal to four or five months of the wet season over most of the natural pastures. Another shortcoming of the natural pastures is the low quality of the herbage, most of the grasses in natural pastures, available energy and crude protein fell short of the animal's (Boran cattle) nutritional requirements during both the dry and wet seasons (Karue, 1974).

The natural pastures are dominated by grasses which when young have higher fiber and lower protein contents than temperate grass species as comparable stage of growth hence, there is growing demand for meat, milk, and other animal products (Olubajo, 1973). Natural pasture is shown to constitute unimproved native or naturalized grasses with little or no legumes and other broad leaves which account for the poor nutritive quality of the pasture for most of the year. The natural pastures constitute the main source of cheap feed for livestock in Southwest and indeed, Nigeria as a whole.

Natural grasslands have a high conservation value and their occurrence on fertile soils has provided large areas of grassland which has been cultivated for crops. Natural grasslands generally contain large amounts of good forage, grass-based animal production considered to be the most cost-effective and sustainable system. Therefore, it is essential to develop pastures which are weed free, pest resistant, productive and adaptable to various situations (Wood, 1997).

Even though natural pastures supply cheap feed for ruminant animals, they are not always the most economical source of forage as they become fibrous and the level of utilization by the

animals grazing them is then drastically reduced (Williamson and Payne, 1978). However, the shortage of feed particularly during the dry season is one of the major factors limiting livestock productivity. On the other hand, due to poor quality of the existing feed, seasonal changes in climate and growth stages of plants, grazing animals are often unable to satisfy their nutritional requirements especially during reproductive stages.

Botanical composition of the pasture is influenced by the joint effect of several environmental factors (climate and physical properties of soil, soil moisture characteristics and topography) (Levente and Andrea, 2005). Grazing animals also have an effect on the botanical composition through trampling, selective grazing and climate is one of the most important factors that determine the type of grassland and its botanical composition. Soils within grassland ecosystems are some of the most productive in the world (White *et al.,* 2000); however, replacement of perennial grassland plants with annual cropping systems has the potential to sharply increase soil erosion and runoff of soil nutrients, reduce soil quality, and increase the eutrophication of water resources (Heathcote *et al.,* 2013).

The dense growth and litter of perennial grassland plants reduces soil erosion by reducing water velocity over the soil surface which reduces the amount of sediment runoff can remove from the soil surface and transport to a new location (Huang *et al.,* 1999; Heathcote *et al.,* 2013). In addition, dense plant root systems and soil biota improve soil aggregate stability (Gyssels *et al.,* 2005) and by reducing water velocity and increasing aggregate stability and formation, grassland plants and soil biota increase water infiltration rates (Franzluebbers, 2002) and storage in the soil profile (Arthur *et al.,* 2013) which increases net primary productivity.

MATERIALS AND METHODS

The experimental sites were the selected states in South-western Nigeria namely: Ogun, Osun, and Oyo State in which two (2) villages were purposely selected in each state, namely: Isa–ope and Awale (Ogun State), Iwo and Otan (Osun State), and Aagba and Alaaga (Oyo State). An area of 100 m^2 land plot was mapped out on the natural grazing areas in each of the selected villages. The areas were sub-divided into five (5) plots of 5x4 m^2 dimension each for effective sampling based on the topography of each area. Thereafter, 1 m^2 quadrat was thrown randomly in each sub-plots to harvest the herbage within each sub-plot and separated into grasses, legumes and weeds. The study was laid out in a 6 × 4 factorial arrangement comprising six (6) villages (Isa-ope, Awela, Iwo, Otan, Aagba, and Alaaga) and four seasons (early rain, late rain, early dry, and late dry) in a randomized complete block design with three replicates.

In each of the seasons, estimation of botanical composition and dry matter yield was obtained from a 1 m^2 quadrat thrown thrice in each site. All the plant materials within the quadrat were harvested at 15 cm above the ground level and weighed fresh in the field. The total fresh weight was taken and later separated into forage and non-forage plants. The forage species were further separated into grasses and legumes; these were identified and weighed.

Botanical composition (%) =

$$\frac{\text{Fresh weight of species component/m}^2}{\text{Total weight of all component/m}^2} \times 100$$

Dry matter percentage =

$$\frac{\text{Weight of dry sample}}{\text{Weight of fresh sample}} \times 100$$

While dry matter yield was estimated as:

Total dry matter yield =
dry matter percentage x fresh sample from 1 m^2

which was calculated in tonnes per hectare afterwards.

RESULTS

The botanical composition of natural grazing area in Awela and Isa-ope villages of Ogun State are presented in Figures 1a and 1b, respectively. In Awela, the most common plant was *Andropogon tectorum* (35%) while *Fuirena ciliaris* (32%) ranged second. Both species were higher in population than *Paspalum conjugatum, Calopogonium mucunoides* (11%) and weeds comprising broad-leave and sedges (Figure 1a).

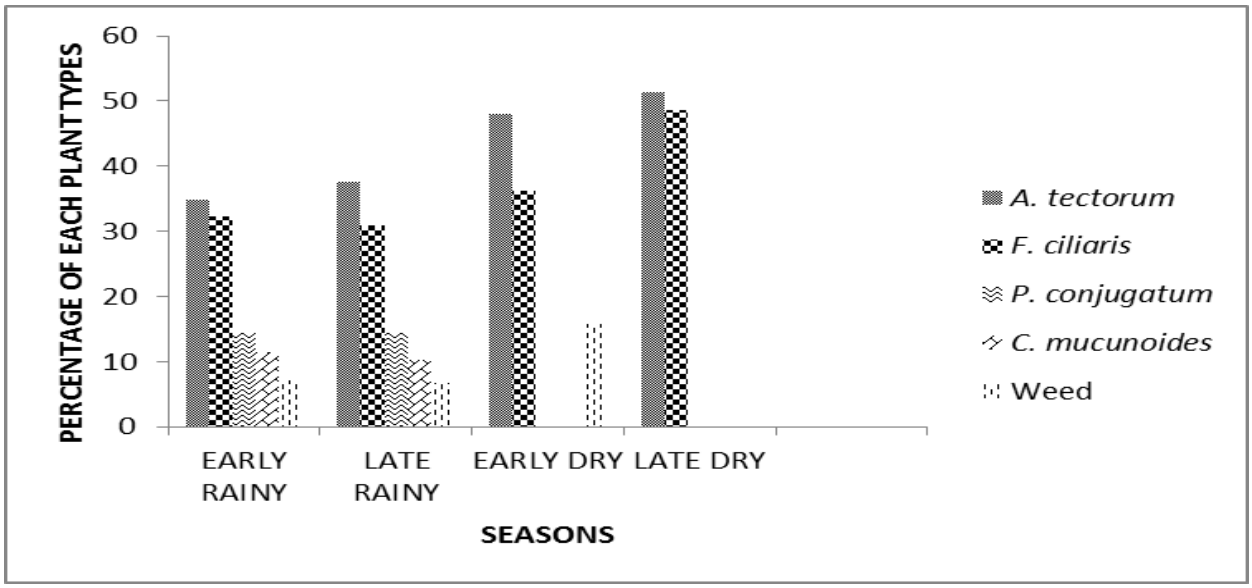

Figure 1a: Botanical Composition of Grazing Areas under Sedentary Pastoral System at Different Seasons in Awela Village, Ogun State.

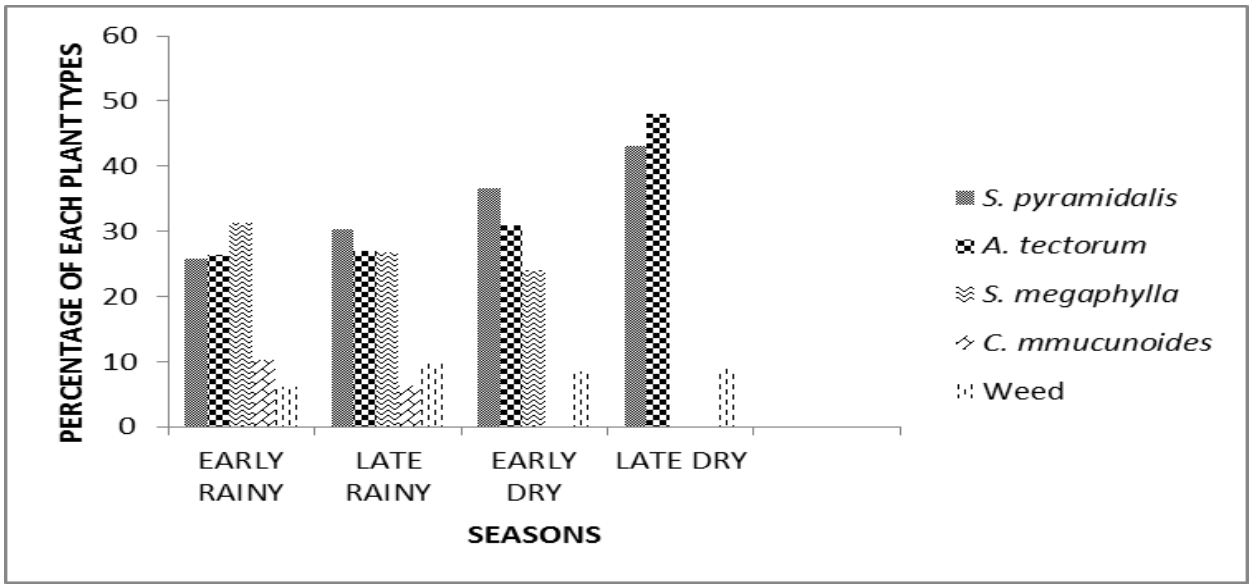

Figure 1b: Botanical Composition of Grazing Areas under Sedentary Pastoral System at Different Seasons in Isa-ope Village, Ogun State.

Likewise, the same trend was observed in the late rainy season but for early dry and late dry season, there was no *P. conjugatum* and *C. mucunoides* except weed population which was the highest in the early dry season (Figure 1a). Similar trend was observed in Isa-ope village of Ogun State with higher population of weeds in early and late dry seasons (Figure 1b).

For Iwo village, *Hyparrhenia rufa* was the highest in population in all the seasons but the highest percentage (65%) was in the early rainy season with others fluctuating between 53% and 57% in the other three (3) seasons. *Acroceras zizanioides* was available in all the seasons with the highest population (33%) in early dry season and others between 25% and 29% in the other seasons.

As observed in Ogun State, there was no *C. mucuniodes* in early and late dry season (Figure 2a) and there was only one grass type (*Cynodon dactylon*) identified in Otan village of Osun State.

The population of *C. dactylon* was between 58% and 71% with progressive increase from early rainy season to late dry season, respectively. As in the other locations mentioned earlier, *C. mucuniodes* was not present in both the early and late dry seasons but had the highest population in the early rainy season (21%).

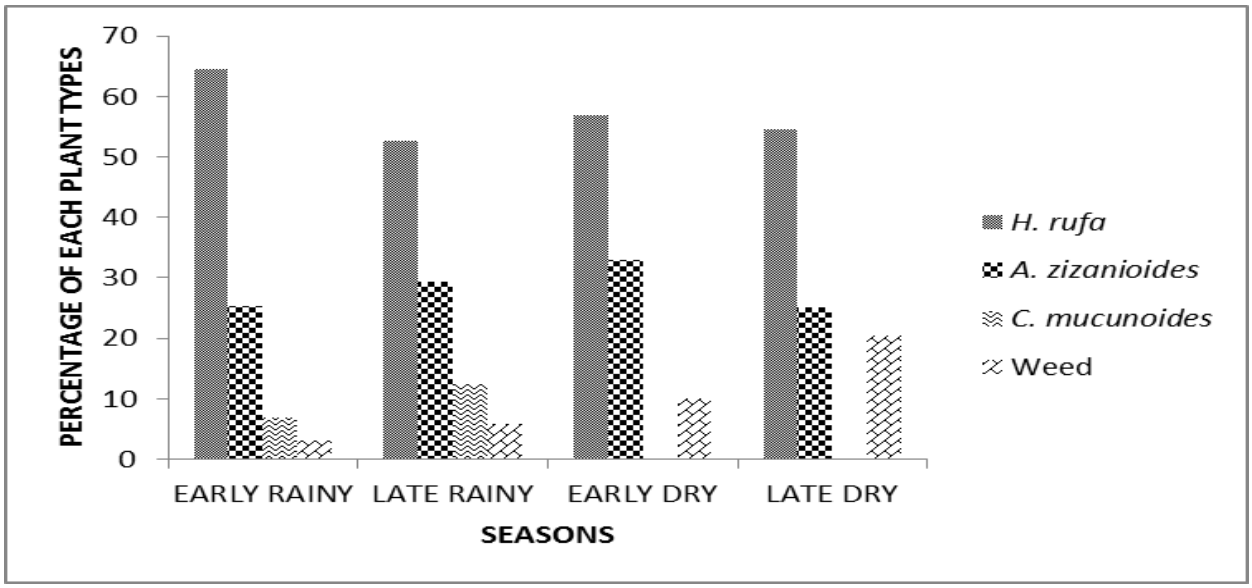

Figure 2a: Botanical Composition of Grazing Areas under Sedentary Pastoral System at Different Seasons in Iwo Village, Osun State.

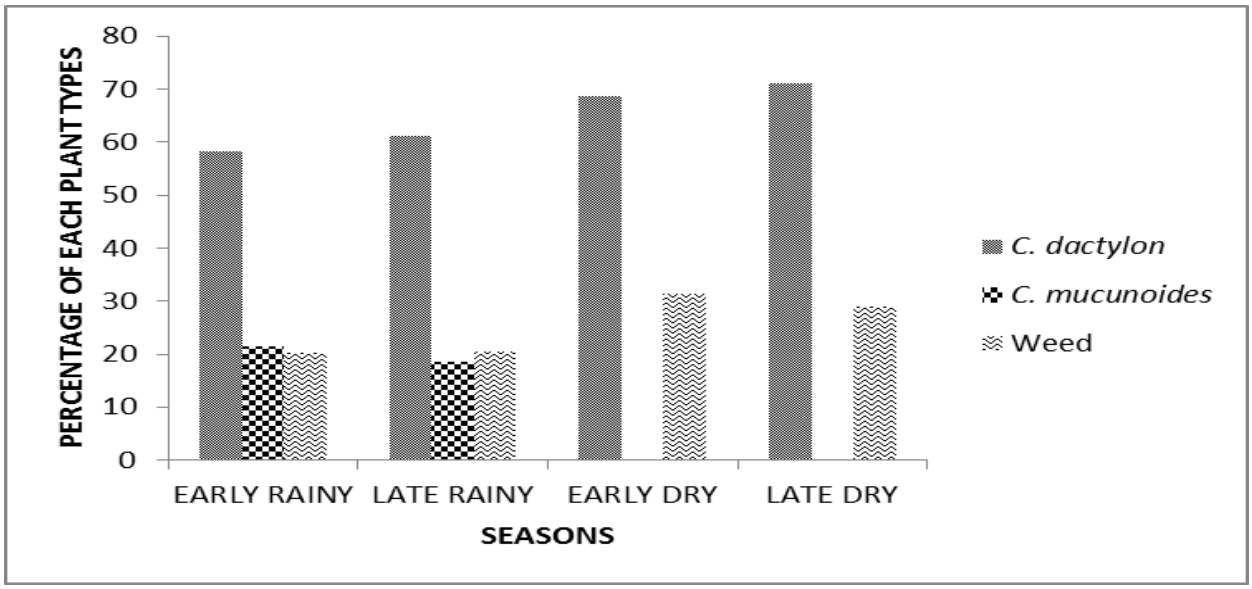

Figure 2b: Botanical Composition of Grazing Areas under Sedentary Pastoral System at Different Seasons in Otan Village, Osun State.

The weed population progressively increased from 20% in early rainy season to 31% in the early dry season (Figure 2b). The commonest grass in Aagba village (Osun state) was *Pennisetum pedicellatum* whose composition ranged from 48% in the early rainy to 51% in the late dry season. Values for both early and late dry seasons were similar in population. *Chloris pilosa* reduced progressively and gradually in population from early rainy (42%) to late dry season (35%).

The population of the weeds was almost similar but the least (11%) was in the early rainy season and the highest in late dry season (14%) while late rainy and early dry seasons were of the same population (12%) (Figure 3a) while *Brachiaria lata* was the dominant grass specie in Alaaga village of Oyo state with population of 36% in the late rainy and 43% in the early and late dry seasons (Figure 3b).

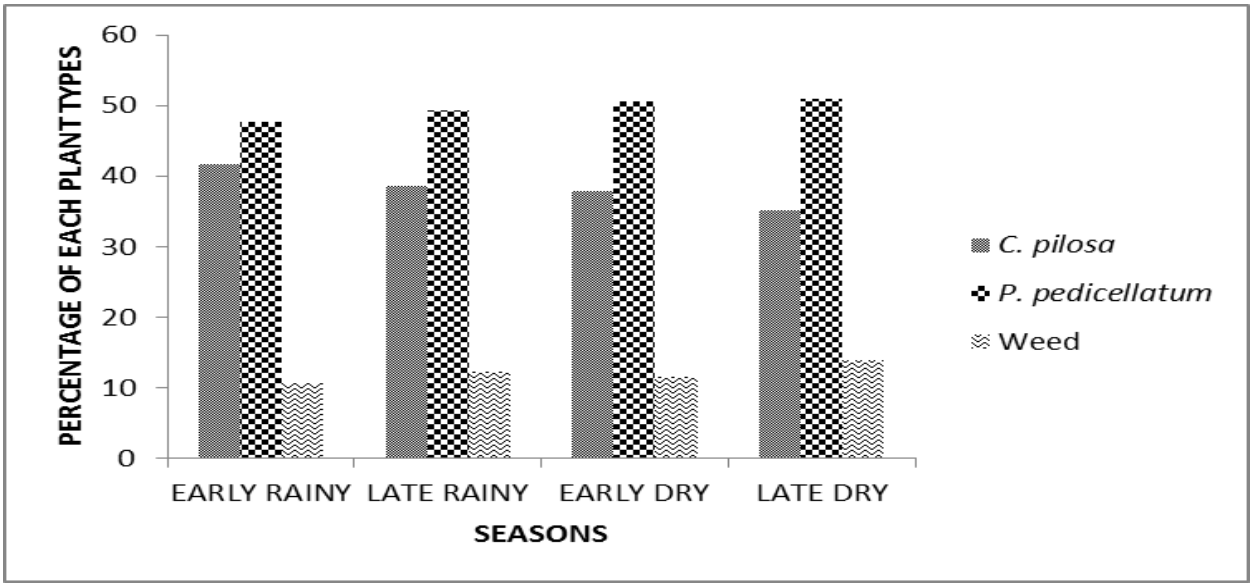

Figure 3a: Botanical Composition of Grazing Areas under Sedentary Pastoral System at Different Seasons in Aagba Village, Oyo State.

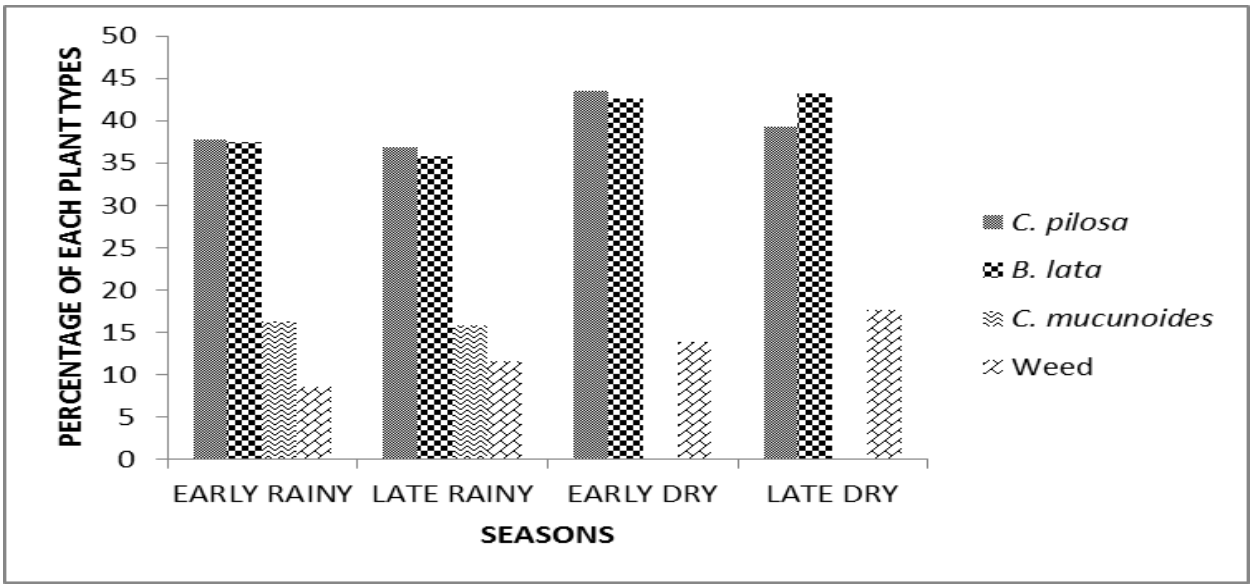

Figure 3b: Botanical Composition of Grazing Areas under Sedentary Pastoral System at Different Seasons in Alaaga Village, Oyo State.

The population of *C. pilosa* and *B. lata* were similar in all the seasons. *C. mucuniodes* was also absent in the early and late dry seasons in this village but was similar in population (16%) in both early and late rainy seasons while the weed population increased progressively from 8% in early rainy to 18% in late dry season.

In all the location the highest dry matter yield was observed in early rainy season and there was progressive reduction in dry matter yield with the least in the late dry season, and the absent of some plants in the early and late dry seasons. In Awela village of Ogun state *Andropogon tectorum* had the highest (0.450t/ha) dry matter yield in early rainy season and all through the others seasons with the least (0.160t/ha) in the late dry season (Figure 4a) and *Setaria megaphylla* had the highest (0.50t/ha) dry matter yield in the early rainy season in Isa-ope village of Ogun state, which drastically reduced to 0.335t/ha by the late rainy season and was absent by the late dry season (Figure 4b).

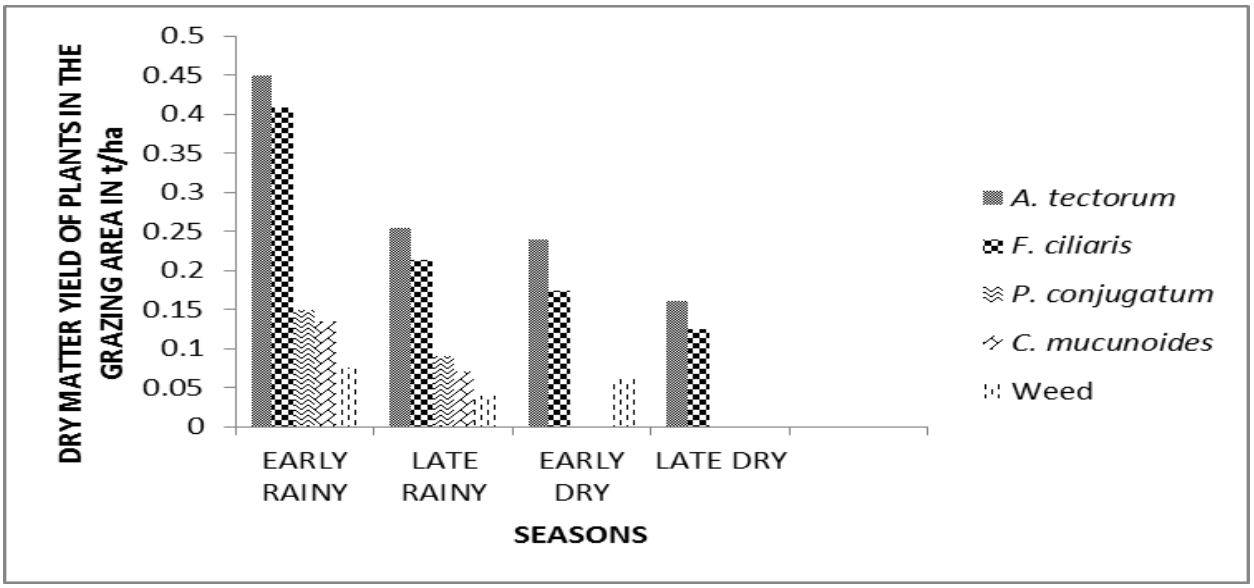

Figure 4a: Dry Matter Yield of Grazing Areas under Sedentary Pastoral System at Different Seasons in Awela Village, Ogun State.

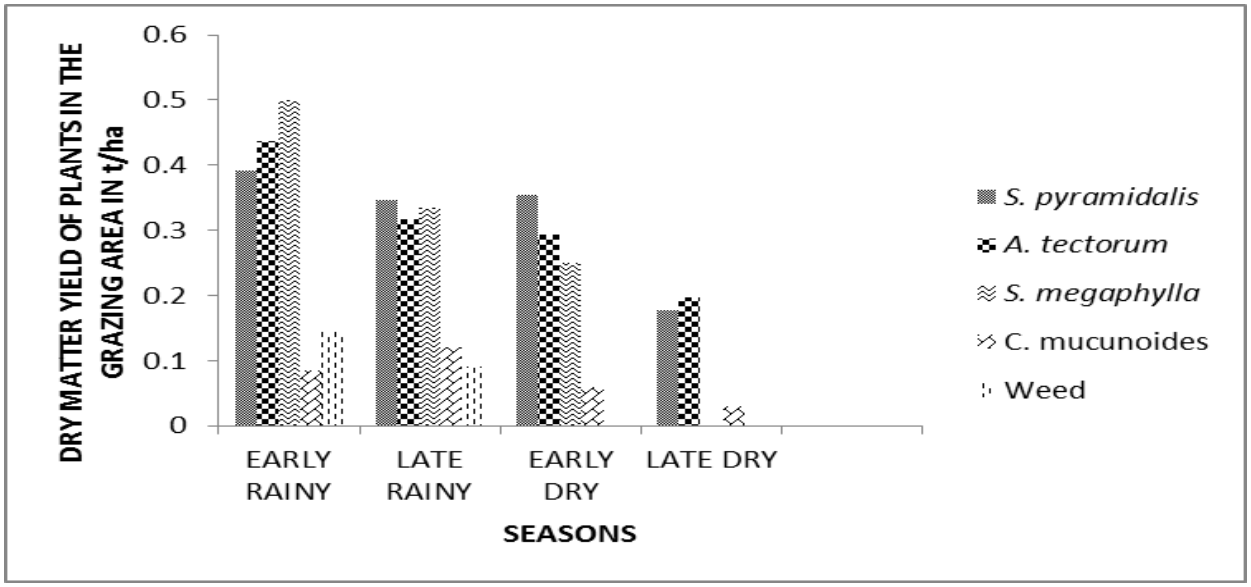

Figure 4b: Dry Matter Yield of Grazing Areas under Sedentary Pastoral System at Different Seasons in Isa-ope Village, Ogun State.

In Iwo village of Osun state, *H. rufa* had the highest (1.213t/ha) dry matter yield in early rainy season and all through the other season with the least value (0.418t/ha) in the late dry season while *C. dactylon* was the only grass present in Otan village of Osun state with the highest (0.448t/ha) dry matter yield recorded in the early rainy season and this increased towards the late dry season with the dry matter yield of 0.203t/ha (Figure 5a and 5b).

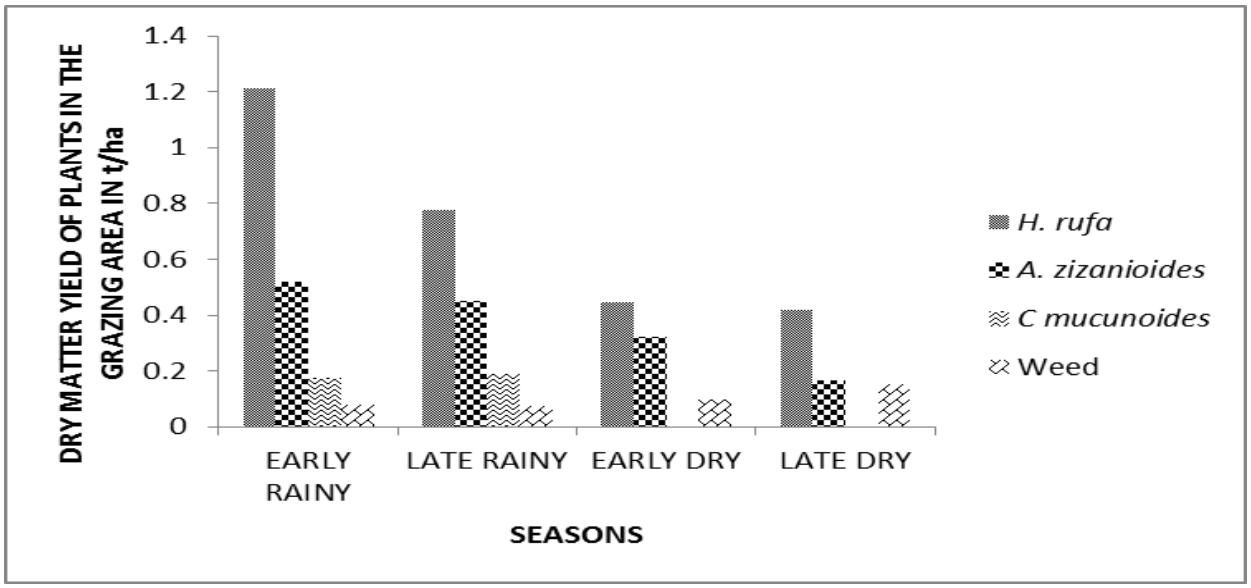

Figure 5a: Dry Matter Yield of Grazing Areas under Sedentary Pastoral System at Different Seasons in Iwo Village, Osun State.

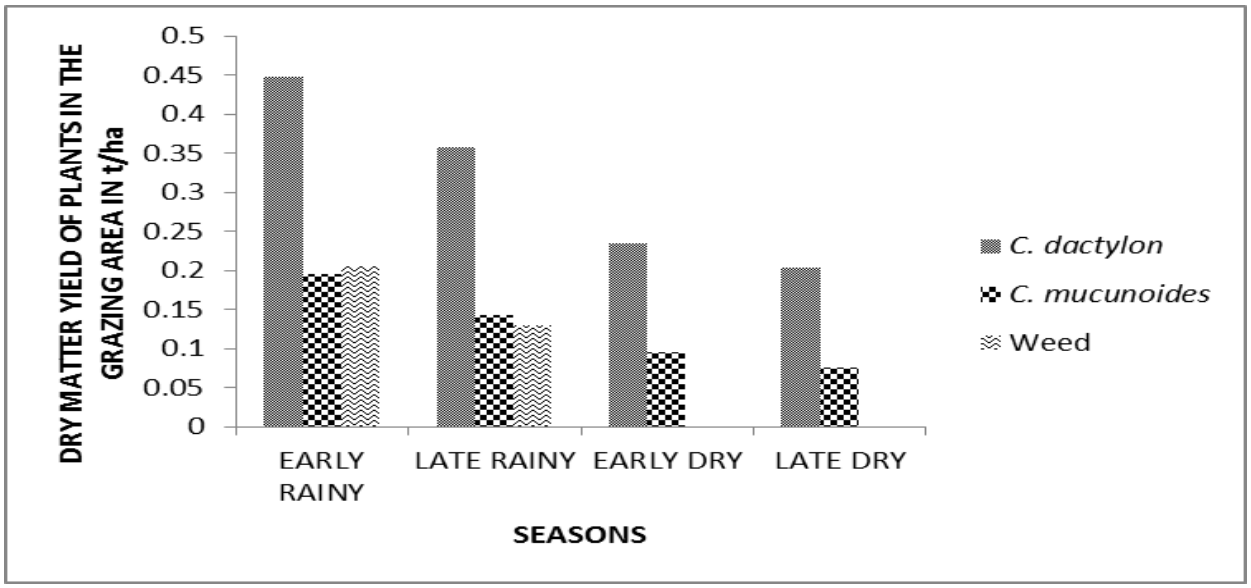

Figure 5b: Dry Matter Yield of Grazing Areas under Sedentary Pastoral System at Different Seasons in Otan Village, Osun State.

The dry matter yield of natural pasture in Aagba village of Oyo State was highest in early rainy season (Figure 6a) and there were two (2) dominant grasses with the dry matter yield of 0.378t/ha for *C. pilosa* and 0.462t/ha for *P. pedicellatum* in the early rainy season but there was decreased in dry matter yield of these two grasses towards the late dry season. For Alaaga village of Oyo State, *C. pilosa* had the highest (0.376t/ha) dry matter yield in the early rainy season which dractically reduced to 0.142t/ha by the late dry season (Figure 6b) and *B. lata* produced between 0.352t/ha in the early rainy season to 0.1625t/ha in the late dry season.

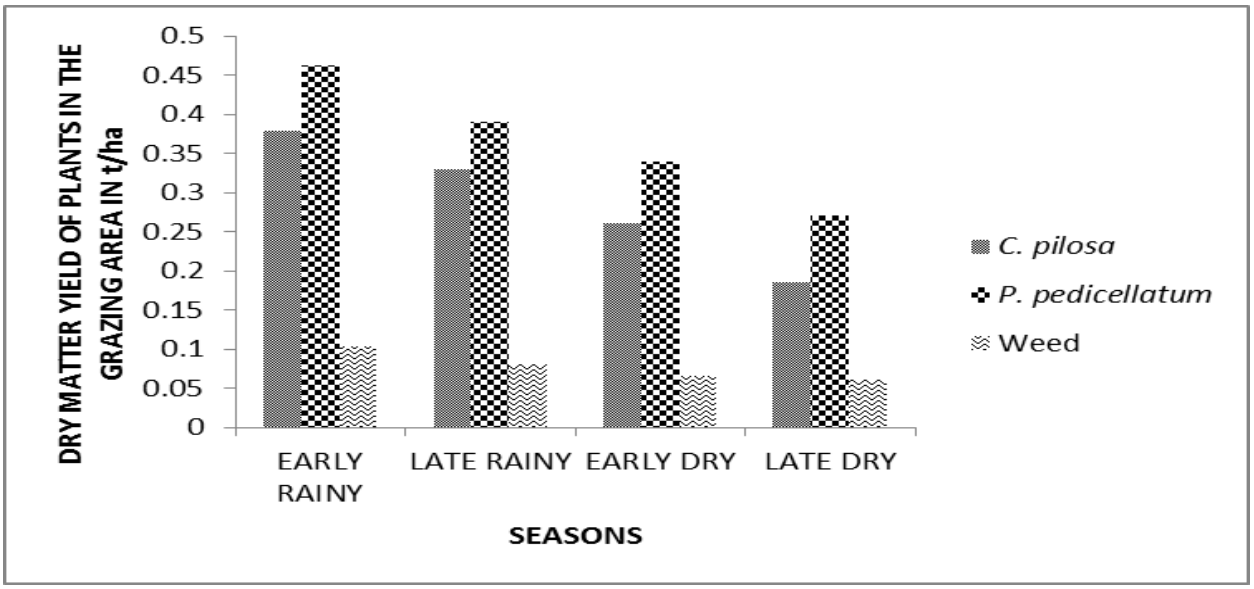

Figure 6a: Dry Matter Yield of Grazing Areas under Sedentary Pastoral System at Different Seasons in Aagba Village, Oyo State.

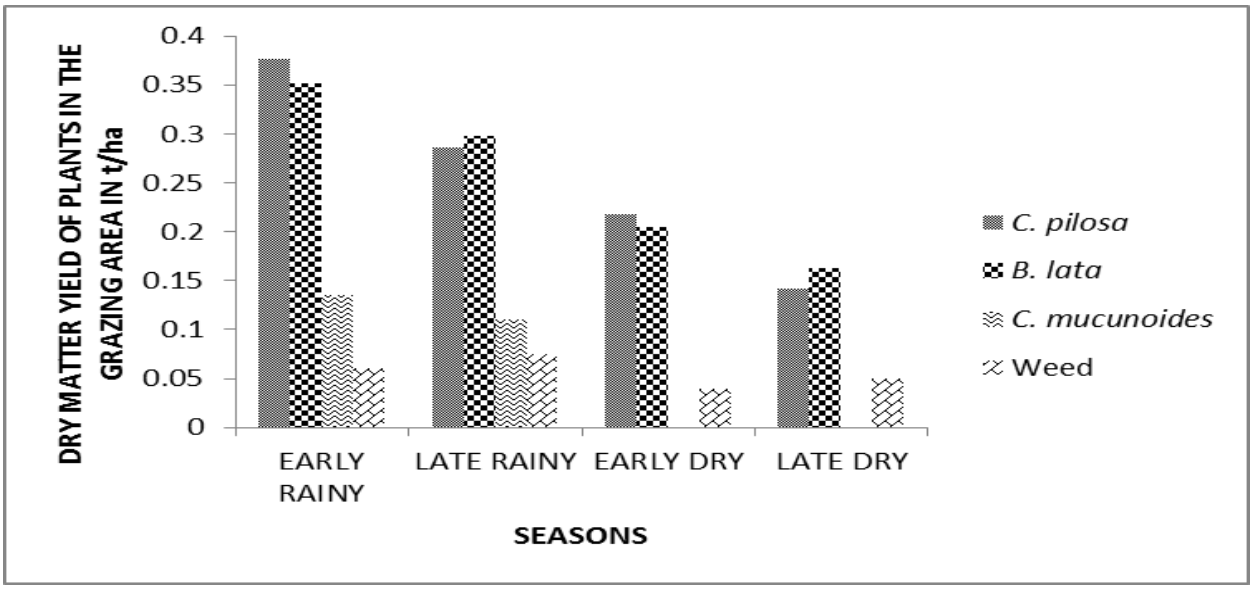

Figure 6b: Dry Matter Yield of Grazing Areas under Sedentary Pastoral System at Different Seasons in Alaaga Village, Oyo State.

Table 1: Physico-Chemical Properties of Soil in Natural Grazing Areas under Sedentary Pastoral System at Different Seasons in South-West Nigeria.

Location	pH	Ca	Mg	K (Cmol)	Na	N (%)	O C (%)	P (mg/kg)
Isa-ope	5.79^{e}	18.91^{d}	3.44^{b}	0.64^{c}	1.14^{c}	0.18^{c}	1.85^{c}	3.65^{e}
Awela	5.54^{f}	22.11^{a}	2.23^{c}	0.21^{e}	0.46^{f}	0.19^{b}	2.08^{b}	2.96^{f}
Iwo	6.05^{d}	5.77^{f}	0.50^{f}	0.32^{d}	0.53^{e}	0.07^{e}	0.66^{f}	4.56^{d}
Otan	7.06^{c}	7.74^{e}	1.53^{d}	0.98^{b}	1.39^{b}	0.08^{e}	0.89^{d}	9.09^{c}
Aagba	8.30^{a}	20.11^{b}	4.32^{a}	2.63^{a}	5.18^{a}	0.26^{a}	2.74^{a}	48.52^{a}
Alaaga	7.22^{b}	19.11^{c}	1.31^{e}	0.32^{d}	0.63^{d}	0.11^{d}	0.86^{e}	20.52^{b}
SEM	0.12	0.38	0.23	0.08	0.13	0.01	0.12	0.86
Season								
Early rain	6.44^{d}	16.53^{a}	2.87^{a}	0.84^{b}	1.46^{c}	0.17^{a}	1.88^{a}	13.23^{d}
Late rain	6.79^{a}	16.06^{b}	2.02^{c}	0.69^{c}	1.38^{d}	0.16^{b}	1.52^{b}	13.66^{c}
Early dry	6.73^{b}	15.19^{c}	1.69^{d}	0.94^{a}	1.77^{a}	0.13^{c}	1.21^{d}	14.46^{b}
Late dry	6.68^{c}	14.72^{d}	2.30^{b}	0.94^{a}	1.61^{b}	0.14^{c}	1.45^{c}	18.19^{a}
SEM	0.25	1.58	0.35	0.21	0.41	0.02	0.21	4.05

$^{a, b, c....f}$:Means along the same column with different superscripts are significant ($p<0.05$).
SEM = Standard Error of Mean
OC = Organic carbon

There were significant ($p<0.05$) differences in the physic-chemical properties of soil in natural grazing areas under sedentary system at different locations and seasons (Table 1).

The pH value ranged from 5.54 in soil of Awela village (Ogun State) to 8.30 in soil of Aagba village (Oyo State). The Ca level in the soil significantly ($p<0.05$) ranged from 5.77cmol in Iwo village (Osun State) to 22.11cmol in Awela village (Ogun State) while the least (0.50cmol) Mg level in the soil was observed in Iwo village (Osun State).

Meanwhile, the soil sampled from Aagba village (Oyo State) recorded the highest (2.63cmol) K level while Aagba village (Oyo State) recorded the highest (5.18cmol) value of Na level in the soil. The Nitrogen level in the soil significantly ($p<0.05$) ranged from 0.07% in Iwo village to 0.26% in Aagba village and the highest (2.74%) value of organic carbon was in the soil taken from Aagba village with the lowest (0.66%) value in soil taken from Iwo village. Meanwhile, the highest value (48.52mg/kg) of Phosphorus was in the soil sampled from Aagba village with the least values (2.96mg/kg) recorded in the soil sampled from Awela village.

The soil taken in late rainy season recorded the highest (6.79) value of pH while Ca level in the soil ranged from 14.72cmol in late dry to 16.53cmol in early rainy season with the highest (2.87cmol) level of Mg in the soil was also recorded in early rainy season and the soil collected in early dry had the highest (0.94cmol and 1.77cmol) levels for K and Na, respectively and the soil in early rain season had the highest (0.17% and 1.88%) N and O.C level in the soil while the soil in late dry season recorded the highest (18.19mg/kg) P level (Table 1).

DISCUSSION

There was high biodiversity of the natural grazing areas of the sedentary which was in agreement with earlier reports (Tesfaye, 2008) that the species composition of rangeland varied depending on topography, climate and soil types. This biodiversity may also be due to different factors like altitude, grazing practices, burning, drought and temperature effects, pests, and erosion as reported (Lawal, 1998) that the type of pasture plants present in a particular area can be linked to the amount of precipitation and soil nutrient status apart from the farming activities.

Despite the diversity, natural pastures had the largest feed resources which could provide 88-90% of the livestock feed as reported by Tesfaye (2008), even though the quality and quantity of natural pastures varies with altitude, rainfall, soil and cropping intensity. Climate especially rainfall plays a primary role in determining the types of

vegetation available for grazing and the subsequent growth responses (Whiteman, 1980).

The quantity and distribution of rainfall are the most important criteria that determine the form and productivity of vegetation Tesfaye (2008). The increase in the quantity of forages during rainy season in this present study was as a result of higher rainfall received during the rainy season, and the lower volume received during the dry season which agrees with the report of Webster and Wilson (1980) that decrease in quantity of forages could be due to the fact that growth of grasses invariably declines with advancement into dry season as a result of reduction in the moisture readily available and accompanying reduction in the uptake of nutrient from the soil.

In all the study areas, only one or two legumes were present while the grasses are between 4 and 6 in all the season and the absence of legumes in the botanical composition in the late dry season was significant. The major difficulties in insufficient quantity of legume in these study areas might have been due to its lack of potential to compete with aggressive grass species which was also reported by Ibrahim and Manntje (1998).

The higher quantity of grass above legume could be due to the fact that majority of grasses are bunch-forming type (tall growing habit) while the legumes are herbaceous. This is because tall bunch-forming grasses always suppress low growing plants by preventing them from having enough sunlight for photosynthesis that is, smothering effects according to Curran *et al.,* (1994).

There was reduction in the dry matter yield of all the plants including the grasses and herbaceous legumes as the dry season sets in that is the highest yield was in the early rainy season with late rainy and early dry seasons almost similar in some cases and the late dry had the least but there was an absence of herbaceous legumes in the dry season which might be due to lack of ability of herbaceous legumes to overcome environmental stress and dry season fire and dry matter yield of all the forage species observed in this study decreased gradually towards the dry season. Generally, the total yield of forage species in the grazing areas increased at the onset of rainfall and decreased in the dry season.

Diminishing dry matter yield of a pasture might be attributed to reduced soil moisture level in the dry season as stated by Olanite (2002) and it was also in agreement with the reports of Ashagre (2008) which held that dry matter yield varied with rainfall as the lower the amount of precipitation, the lower the dry matter yield.

The changes in soil pH over the seasons which was higher in late rain and early dry season in this study were in agreement with the result of Fatubarin and Olojugba, (2014) and this would be attributed to the little rainfall and probably due to dry season bush burning which was an annual occurrence. Low soil pH observed in early rain and late dry seasons in this study might be due to little or no rains, which could result in little or no movement of cations down the profile in part or due to the distribution of soil organic matter which served as store house for the exchange bases and it could also be due to the distribution of exchangeable acidity.

In the dry seasons, lower Ca contents were observed in the soil with higher contents of K and Na and this could be attributed to these elements being utilized by the regenerating plants, since these were reputed for their vigorous regeneration and growth following annual fires (Hopekins, 1974). Higher values of soil organic carbon in rainy season with lower values in dry seasons were similar to the result of Fatubarin and Olojugba, (2014) and it might be due to low rains and burning that usually occurred in the area.

Increased nitrogen contents at the early and late rainy seasons could be best explained by a possible increase in activity of nitrogen fixing microbes and evidence affirmed to show that increased biological nitrogen fixation along with increased mineralization rates occurred during rainy season, which resulted in increased nitrogen content at this time (Bergeron *et al.,* 2002). Slight increase in phosphorus in late and early dry seasons may be due to fire.

CONCLUSION

The botanical composition varied with the seasonal changes. In the early and late dry seasons, herbaceous legume like *Calopogonium mucunoides* and some grasses like *Paspalum conjugatum* and *Setaria megaphylla* were absent and the forages harvested during the early rainy season had the highest dry matter yield in all the locations and gradually decreases towards the

late dry season. The soil physic-chemical properties varied greatly with the location and the season of the year. Therefore, forages are to be harvested frequently during the rainy season when the growth are flushy and luxurant up to the end of the late rainy or early dry seasons and it can also be conserved as hay or silage to retain its quality.

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SUGGESTED CITATION

Okukenu, O., P. Dele, B. Akinyemi, A. Olajide, O. Ogunrombi, and A. Adekale. 2018. “Botanical Composition, Dry Matter Yield, and Soil Physio-Chemical Properties of Natural Grazing Areas under Sedentary Pastoral System at Different Seasons in South-West Nigeria”. *Pacific Journal of Science and Technology*. 19(2):295-306.

Pacific Journal of Science and Technology