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**ORIGINAL RESEARCH ARTICLE**

# Assessment of chemical composition of natural pasture oversown with two *Stylosanthes* species for ruminant feeding

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## ABSTRACT

***Chemical composition of a Panicum maximum dominated natural pasture were evaluated. Two legumes (Stylosanthes guianensis cv. Cook and Stylosanthes hamata cv. Verano), two tillage methods (zero-tillage and minimal tillage) and two planting methods (broadcasting and drilling) were combined into eight (8) treatments and replicated 4 times as a 2 × 2 × 2 factorial arrangements in a randomized complete block design. The two legumes were oversown into the natural pasture. Samples of existing dominant grass (P. maximum), sown legumes, and grab samples were taken for proximate and fibre analyses, 8 months after planting which is early period of rainy season. Results revealed that crude protein (CP, 6.48-14.45%), neutral detergent fibre (NDF, 65.50-78.50%) of P. maximum, ash (8.75-15.60%), CP (8.87-16.48%), ether extract (EE, 0.75-5.00%), acid detergent lignin (ADL, 18.5-41.00%), cellulose (10.50-36.00%) and hemicellulose (16.50-33.00%) of the two legumes varied significantly (p<0.05). There were significant variations (p<0.05) in ash (9.25-15.63%), CP (11.00-17.84%), EE (1.50-5.00%) and NDF (65.5078.50%) contents of grab samples. The study concluded that CP contents were generally high above recommended minimum requirement but in grab>legumes>grass order. CP contents were better enhanced by oversowing through drilling of S. guianensis with either tillage methods or broadcast of S. hamata notwithstanding zero tillage. The forages would be poorly digested owing to high fibre contents amassed over long growing time; hence periodic cutting or grazing is encouraged.***

**Keywords:** Fibre, Proximate, *P.* maximum, *S. guianensis* and *S. hamata*

## INTRODUCTION

Natural pastures are the cheapest source of ruminant feeds in Nigeria. A regular supply of quality forage is essential for profitable ruminant farming. Natural pastures are capable of supporting animal productivity in the early rainy season with little or no problem relating to dry matter yield and nutritive quality, however, as the dry season approaches, available species usually become poor in all indices of quality. Natural pasture species in tropical countries are reported to be low in quality causing very low production per animal and per hectare (Henzell and Mannetje, 1980) and they barely satisfy the nutritional requirements of animals; even for maintenance (Mohamed-Saleeem, 1994).

Natural pasture can be potentially improved through application of appropriate fertilizers, oversowing with legumes and proper grazing management. Oversowing involves seeding directly, either by sod seeding or surface broadcasting, into a live, chemically killed or partly disturbed natural grassland (Cook, 1980).

Stylosanthes species have been recognized for retention of their nutritive value and palatability in the dry season. They also improve soil fertility through nitrogen fixation for enhanced yield. The role of Stylosanthes in improving the productivity of pastures, animals and crops in Nigeria has long been documented (Mohamed-Saleem and Suleiman, 1986; Otchere, 1986).

In order to intensify the use of the natural pastures by traditionally managed ruminant animals and increase productivity of ruminants grazing these pastures, there is need to improve yield and quality of forage from natural pasture. Therefore, this study seeks to investigate the influence of oversowing Stylosanthes on the proximate composition and fibre constituents of a natural pasture.

## MATERIALS AND METHODS

### Description of experimental site

The field experiment was carried out at Oja-Odan, a town in Yewa North Local Government Area of Ogun State, Nigeria. The soil at the experimental site is similar to the pre-classified Iwo series of alfisols (Nwachokor and Uzu, 2008). It contained total N (0.12%), organic C (1.41%), CEC (20.90 cmol/Kg), pH (6.52), available P (27.65 mg $kg^{-1}$) and sandy loam particles. The laboratory analyses were carried out at the analytical laboratory of the Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta. Both sites lie in the Derived Savanna agro-ecological zone of Southwest, Nigeria. Oja-Odan is about 20.18 km and 78.82 km away from Ilaro and Abeokuta, the Ogun State capital, respectively. It lies on latitude 7º 1' 2.6'' N and longitude 2º 50' 41'' E, at altitude 35m (Google Earth, 2013). Abeokuta lies on latitude 7º 9' 39'' N, longitude 3.5º 20' 54'' E, at altitude 67m. Abeokuta records a mean annual rainfall of 1230mm in bimodal pattern with peaks in July and September and it experiences high (83-100%) and low (55-84%) relative humidity during the rainy and dry seasons, respectively (OORBDA, 2014).

### Experimental design

Two legumes (*S. guianensis* cv. Cook and *S. hamata* cv. Verano), two tillage methods (Zero-tillage and minimal tillage) and two sowing methods (broadcasting and drilling) constituted the treatments, totaling eight (8) treatment combinations. The treatments were arranged as 2 × 2 × 2 factorial in a randomized complete block design with 4 replicates. Each replicate was sub-divided into eight (8) plots, giving a total of 32 plots. The treatments were randomly allotted to the plots such that each treatment occurred once per replicate.

### Land preparation, planting materials and oversowing

A land area of 31m × 15m of *P. maximum* dominated natural pasture, divided after initial land clearing to 20cm stubble height for easy access into individual plot size of $3m^2$, 1m inter-plots spaces and 1m between replicates. Prior to oversowing, the plots assigned with minimal tillage treatments were further slashed to 5cm stubble height such that top soil was minimally agitated (between 0-5 cm soil depth) with no serious overturning as applicable in intensive or conventional tillage, while there was no soil agitation or further slashing on the zero-tilled plots. *Stylosanthes guianensis* cv. Cook and *Stylosanthes hamata* cv. Verano were oversown into the plots in September, 2013. Legume seeds were scarified through placing of seeds in cloth bag, tied, immersed in boiling water for 3 minutes, and thereafter spread under a shade to dry before planting with either sowing methods at $7kgha^{-1}$ seed rate. Drilling was achieved with seed being placed along each row within the plots at the spacing of 50cm. The seeds were evenly spread on plots allotted for broadcast method. Single superphosphate (SSP) fertilizer was broadcast on the plots at onset of rains (April, 2014) at the rate of 60kg/ha (13.2 kg/ha $P_20_5$).

### Forage sampling and chemical analyses

Herbage samples of *P. maximum*, sown *S. guianensis*, *S. hamata* and grab samples on each plot of the oversown natural pasture were harvested at height 15cm, 8 months after planting, oven-dried at 65ºC until constant weight and ground in a Wiley mill to pass through 1.0mm sieve screen. The grab samples were collected using hand-grab technique (Olanite, 2002). Five handfuls of grab samples of the pasture species were randomly harvested on each plot to mimic prehensions and harvesting by grazing animals or to simulate how a cow wraps its tongue around forages for harvesting. The forages were cut at the grazing level (usually the top 1/3 of the plant) while roots, soil clumps, or lower stems that were pulled out with the samples were eliminated (Ray Smith *et al*., 2009). Proximate composition (dry matter-DM, crude protein-CP, ether extract-EE, crude fibre-CF and ash) was determined according to the procedure of A.O.A.C (2000). Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) were determined using the method of Van Soest *et al*. (1991). Cellulose was estimated as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF.

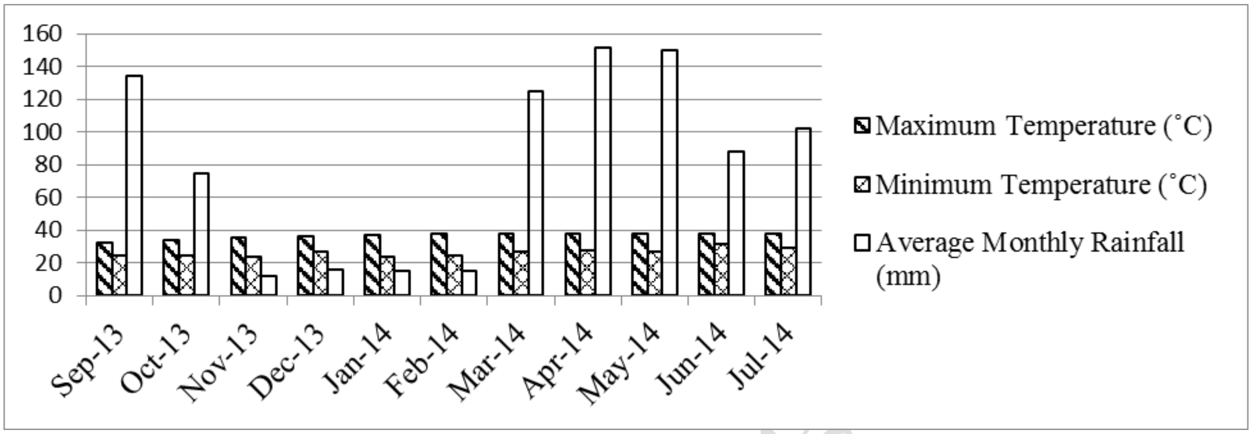


Figure 1: Temperature and rainfall in Abeokuta for the duration of the study (September 2013-July 2014). Source: Ogun-Osun River Basin Development Authority (OORBDA, 2014)

**RESULTS**

The interactive effects of species, sowing and tillage methods on chemical composition (%) of *P. maximum* in the oversown pasture are shown in Table 1. Results revealed that there were no variations in parameters (ash, DM, CF, EE, ADF, ADL, cellulose and hemicelulose) measured (p>0.05), except for CP and NDF contents (p<0.05). Broadcast of *S. hamata* on zero tilled plot enhanced higher (14.45%) CP content compared to the least (6.48%) value obtained in the broadcast of *S. hamata* on minimally tilled plots. NDF values ranged from 65.50% to 78.50% in drilling and broadcasting of *S. hamata* on minimally tilled plots respectively.

Interactive effects of legume species, sowing and tillage methods on chemical composition (%) of *S. hamata* and *S. guianensis* as presented in Table 2 showed that ash, CP, EE, ADL, celulose and hemicelulose results varied significantly (p<0.05). Higher (16.48%) and least (8.87%) CP contents were obtained from the drilling of *S. guianensis* on zero-tilled plots and broadcast of the same legume on minimally tilled plots respectively. Significantly (p>0.05) higher ADL (41.00%) was obtained in broadcast of *S. guianensis* on minimally tilled plots while least ADL (9.00%) occurred in the drilling of *S. guianensis* on minimally tilled plots. EE ranged from 0.75% in broadcast of *S. hamata* on minimally tilled plots to 5.00% in drilling of *S. guianensis* on untilled plots (zero tillage). Higher ash (15.60%) content was obtained for *S. hamata* when drilled on zero tilled plots.

There were significant variations (p<0.05) in ash, CP, EE and NDF contents of grab samples while other parameters did not vary (p>0.05) (Table 3). CP ranged from 11.09% in broadcast of *S. guianensis* on untilled plots to 17.84% in drilling of *S. guianensis* on minimally tilled plots. A higher ash (15.63%) value of the grab samples was obtained when *S. hamata* was drilled on zero tilled plots. Broadcast of *S. hamata* on minimally tilled plots had higher (p<0.05) NDF (78.50%) while drilling of *S. hamata* on minimally tilled plots recorded the least (65.50%)

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**Table 1: Interactive effects of legume species, sowing and tillage methods on chemical composition of *Panicum maximum* in oversown natural pasture**

| Species | Sowing | Tillage | DM | ASH | CF | CP | EE | NDF | ADF | ADL | CEL | HEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *S. guianensis* | Broadcast | Minimal | 96.25 | 25.00 | 76.00 | 8.74[d] | 1.00 | 76.50[ab] | 51.50 | 21.50 | 55.00 | 29.50 |
| *S. guianensis* | Broadcast | Zero | 96.50 | 15.63 | 75.50 | 7.26[e] | 1.50 | 72.00[ab] | 52.50 | 13.00 | 59.00 | 32.00 |
| *S. guianensis* | Drill | Minimal | 97.00 | 21.25 | 70.50 | 8.67[d] | 0.75 | 78.00[ab] | 45.00 | 21.50 | 56.50 | 31.50 |
| *S. guianensis* | Drill | Zero | 96.25 | 18.00 | 78.50 | 13.10[b] | 1.25 | 72.00[ab] | 52.50 | 20.00 | 52.00 | 31.50 |
| *S. hamata* | Broadcast | Zero | 97.00 | 15.75 | 74.50 | 14.45[a] | 2.00 | 73.50[ab] | 53.50 | 17.00 | 56.00 | 33.00 |
| *S. hamata* | Broadcast | Minimal | 97.25 | 15.75 | 75.50 | 6.48[f] | 1.00 | 78.50[a] | 52.00 | 15.50 | 53.00 | 33.50 |
| *S. hamata* | Drill | Zero | 94.50 | 26.25 | 77.00 | 10.38[c] | 0.75 | 78.00[ab] | 53.50 | 29.00 | 49.00 | 39.00 |
| *S. hamata* | Drill | Minimal | 96.75 | 15.75 | 72.50 | 7.25[e] | 0.50 | 65.50[b] | 50.50 | 23.00 | 42.50 | 30.50 |
| SEM | | | 0.42 | 1.40 | 1.44 | 0.49 | 1.20 | 1.39 | 1.35 | 2.12 | 2.68 | 1.01 |

[a, b, c]: Means on the same column with different superscripts differ significantly ($P< 0.05$); SEM: Standard error of means; DM: Dry matter; CP: Crude protein; CF: Crude fibre; EE: Ether extract; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin; CEL: Cellulose; HEM: Hemicellulose

**Table 2: Interactive effect of species, sowing and tillage methods on chemical composition (%) of *Stylosanthes hamata* and *Stylosanthes guianensis* oversown into natural pasture**

| Species | Sowing | Tillage | DM | ASH | CF | CP | EE | NDF | ADF | ADL | CEL | HEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *S. guianensis* | Broadcast | Minimal | 94.75 | $9.25^{b}$ | 72.50 | $8.87^{f}$ | $1.50^{c}$ | 76.50 | 51.50 | $41.00^{a}$ | $10.50^{b}$ | $25.00^{ab}$ |
| *S. guianensis* | Broadcast | Zero | 96.25 | $9.50^{b}$ | 74.50 | $13.85^{de}$ | $3.25^{bc}$ | 72.00 | 52.50 | $30.50^{ab}$ | $22.00^{ab}$ | $19.50^{ab}$ |
| *S. guianensis* | Drill | Minimal | 94.50 | $9.00^{b}$ | 73.00 | $13.38^{e}$ | $4.50^{b}$ | 78.00 | 45.00 | $29.00^{ab}$ | $36.00^{a}$ | $33.00^{a}$ |
| *S. guianensis* | Drill | Zero | 93.50 | $9.75^{b}$ | 70.00 | $16.48^{a}$ | $5.00^{a}$ | 72.00 | 52.50 | $18.50^{bc}$ | $34.00^{a}$ | $19.50^{ab}$ |
| *S. hamata* | Broadcast | Zero | 93.25 | $8.75^{b}$ | 74.00 | $15.07^{bc}$ | $0.75^{c}$ | 73.00 | 53.50 | $32.50^{ab}$ | $21.00^{ab}$ | $19.50^{ab}$ |
| *S. hamata* | Broadcast | Minimal | 98.00 | $9.25^{b}$ | 71.50 | $14.29^{cd}$ | $3.75^{bc}$ | 78.50 | 52.00 | $39.00^{a}$ | $20.00^{ab}$ | $25.50^{ab}$ |
| *S. hamata* | Drill | Zero | 96.25 | $15.6^{a}$ | 70.00 | $15.28^{b}$ | $1.25^{c}$ | 78.00 | 53.50 | $26.00^{abc}$ | $27.50^{ab}$ | $24.50^{ab}$ |
| *S. hamata* | Drill | Minimal | 92.75 | $9.25^{b}$ | 71.50 | $15.13^{bc}$ | $3.50^{bc}$ | 67.00 | 50.50 | $26.00^{abc}$ | $24.50^{ab}$ | $16.50^{b}$ |
| SEM | | | 0.63 | 0.47 | 1.35 | 0.39 | 0.43 | 1.27 | 1.35 | 2.60 | 2.61 | 1.62 |

$^{a, b, c}$: Means on the same column with different superscripts differ significantly (P< 0.05); SEM: Standard error of means; DM: Dry matter; CP: Crude protein; CF: Crude fibre; EE: Ether extract; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin; CEL: Cellulose; HEM: Hemicellulose

**Table 3: Interactive effect of species, sowing and tillage methods on chemical composition (%) of grab representatives of oversown natural pasture**

| Species | Sowing | Tillage | DM | ASH | CF | CP | EE | NDF | ADF | ADL | CEL | HEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *S. guianensis* | Broadcast | Minimal | 94.75 | $9.25^{c}$ | 72.50 | $11.09^{d}$ | $1.50^{b}$ | $76.50^{ab}$ | 51.50 | 21.50 | 55.00 | 22.00 |
| *S. guianensis* | Broadcast | Zero | 96.25 | $13.00^{ab}$ | 74.00 | $15.30^{b}$ | $4.25^{a}$ | $72.00^{ab}$ | 52.50 | 13.00 | 59.00 | 23.75 |
| *S. guianensis* | Drill | Minimal | 94.50 | $9.50^{c}$ | 73.00 | $17.84^{a}$ | $4.50^{a}$ | $78.00^{ab}$ | 45.00 | 21.50 | 56.50 | 17.50 |
| *S. guianensis* | Drill | Zero | 93.50 | $9.50^{c}$ | 70.00 | $13.49^{c}$ | $5.00^{a}$ | $72.00^{ab}$ | 52.50 | 20.00 | 52.00 | 23.00 |
| *S. hamata* | Broadcast | Zero | 93.25 | $9.75^{c}$ | 74.00 | $17.33^{a}$ | $2.00^{b}$ | $73.50^{ab}$ | 53.50 | 17.00 | 56.00 | 25.00 |
| *S. hamata* | Broadcast | Minimal | 98.00 | $10.00^{ac}$ | 71.50 | $12.14^{e}$ | $3.25^{ab}$ | $78.50^{a}$ | 52.00 | 15.50 | 53.00 | 18.25 |
| *S. hamata* | Drill | Zero | 96.25 | $15.63^{a}$ | 70.00 | $13.10^{c}$ | $1.50^{b}$ | $78.00^{ab}$ | 53.50 | 29.00 | 49.00 | 20.50 |
| *S. hamata* | Drill | Minimal | 92.75 | $10.00^{bc}$ | 71.50 | $15.89^{b}$ | $4.75^{a}$ | $65.50^{b}$ | $50.50^{a}$ | 23.00 | 42.50 | 29.75 |
| SEM | | | 0.63 | 0.49 | 1.35 | 0.85 | 0.34 | 1.39 | 1.35 | 2.12 | 2.68 | 1.39 |

$^{a, b, c}$: Means on the same column with different superscripts differ significantly ($P< 0.05$); SEM: Standard error of means; DM: Dry matter; CP: Crude protein; CF: Crude fibre; EE: Ether extract; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; ADL: Acid detergent lignin; CEL: Cellulose; HEM: Hemicellulose

## DISCUSSION

The chemical components of forage usually indicate the level at which consumption and utilization would yield a positive or negative animal output. In the present investigation, the crude protein results of the two Stylosanthes species and grab samples were higher than the range (4-8%) reported when same legumes were harvested on natural pasture and conserved in the dry season (Muraina *et al*., 2013). Similarly, the CP results were higher than the recommended minimum requirement (6%) for ruminant animals in the tropics (NRC, 1984; Humphreys, 1991), minimum level (7%) required for optimum rumen function (Van Soest, 1994), and 8% suggested for ruminal function (Norton, 1994). Hence, the legumes would be appropriate to enhance the often limiting protein through nitrogen fixation and ensuring adequate legume presence in the natural pasture for ruminants' utilization. The CP contents obtained in this study might be higher than these, if there were quarterly grazing or cutting of the legumes and therefore reduces the dilution of the CP contents of the forage crops by the rapid accumulation of cell wall carbohydrates at the latter stages of growth (Van Soest, 1994). Grass maturity is usually negatively related to CP content (Norton, 1981). In addition, the CP content of grass obtained in this study fell within the range (3-11%) reported for grasses in grazed natural pasture and fodder bank during late dry and early rainy season (Mani *et al*., 1992).

Accumulation of dry matter, crude fibre and ash overtime were observed in this present study. Ash, DM and CF were higher than those reported for grasses and grass-legume mixtures (Ajayi *et al*., 2007). This may be attributed to the fact that there was quarterly harvesting of the pasture in the earlier report of Ajayi *et* al. (2007). Ash contents of *P. maximum* were higher than the range (9-13%) reported for grasses in fodder banks and natural pastures (Mani *et al*., 1992).

The NDF contents of *P. maximum* and the two Stylosanthes investigated in this study were within the range reported for grasses (40-65.5%) and Stylosanthes (62-72%) (Mani *et al*., 1992). Roughages with NDF content of 45-65% and below 45% are generally considered as medium and high quality feeds, respectively (Singh and Oosting, 1992). The NDF contents of these pasture components were higher than the range of medially rated feeds (Singh and Oosting, 1992). Thus, the NDF contents of the *P. maximum*, Stylosanthes and grab samples revealed that they would be poorly digested, since increase in NDF content has been associated with decrease in digestibility and hence feed intake (Van Soest, 1994; McDonald *et al*., 2002).

Rate of digestibility of forage in rumen is related to the proportion and extent of lignification (Van Soest, 1994). Buxton and Rusell (1988) opined that lignin contents in cell wall of forages depend mostly on proportion and maturity of stem parts of plants, such that immature stems are almost completely digestible. The ADL results of the two Stylosanthes species, grab samples and *P. maximum* were higher than the values reported by Bayble *et al*. (2007) for Napier grass. Harvesting or quarterly cutting-back of the oversown pasture would reduce lignification and thereby aids digestibility and utilization.

## CONCLUSION

Crude protein contents were generally high above recommended minimum requirement for ruminants. However, drilling of *S. guianensis* with either tillage methods or broadcast of *S. hamata* notwithstanding zero tillage enhanced CP more than other oversowing treatments employed. The forages would be poorly digested due to high fibre contents amassed over long growing time; hence periodic cutting or grazing is encouraged. Drilling of *S. hamata* with zero tillage enhanced higher ash contents of the investigated pasture components.

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