

Full Length Research Paper

Effect of anhydrous magnesium sulphate fertilizer and cutting frequency on yield and chemical composition of *Panicum maximum*

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Accepted 14 May, 2007

Effect of anhydrous magnesium sulphate fertilizer on *Panicum maximum* yield and chemical composition of the resultant herbage harvested at 3, 4 and 5 weeks of age was investigated. The treatments were labeled T1 to T6. T1 was fertilized and harvested at 3 weeks cutting interval, T2 was fertilized and harvested at 4 weeks cutting interval, T3 was fertilized and harvested at 5 weeks cutting interval, T4 was not fertilized but harvested at 3 weeks cutting interval, T5 was not fertilized but harvested at 4 weeks cutting interval and T6 was not fertilized but harvested at 5 weeks cutting interval. The results showed significant differences ($P < 0.05$) in dry matter yield between treated and untreated grass and the intervals of cuttings. Although, there was no significant difference ($P > 0.05$) between the treated and the untreated grass at the same cutting interval, there was a marginal increase with the treated showing superiority in all the cases. Also observed was increase in yield as the cutting interval increased in both cases of treated and untreated grass. It was also found that there was no interaction between fertilizer application and cutting frequency. The crude protein contents of both the treated and untreated grass at different cutting intervals was significantly ($P < 0.05$) different. At the equivalent cutting intervals between the treated and the untreated grass, the crude protein contents, though, not significantly ($P > 0.05$) different was consistently higher than that of the untreated. It was also found that the crude protein content of the grass declined as the plant aged. The NDF contents were higher in the untreated grass than the treated grass. The magnesium fractions of the treated grass at the cutting intervals were significantly ($P < 0.05$) different while those of the untreated grass at all the cutting intervals were similar ($P > 0.05$). The herbage magnesium content between the treated and the untreated at the same cutting intervals were different as the magnesium contents in treated grass were consistently higher than the untreated at the same cutting intervals. In the treated grass, the magnesium contents of the herbage grass did not show a definite pattern as the cutting interval increased but did decrease in the untreated grass as the grass matured. The calcium contents of treated and untreated grass at different cutting intervals were similar ($P > 0.05$) in T1 and T3 but different ($P < 0.05$) in T2. The herbage calcium content seemed not to be influenced by magnesium fertilizer application. Also age at cutting seemed not to show effect on the herbage calcium content in both cases of treated and untreated grass. The potassium content of both the treated and untreated grass was similar ($P > 0.05$). In both the treated and the untreated grass, the potassium contents of the grass decreased with age.

Key words: Anhydrous magnesium sulphate fertilizer, *Panicum maximum*, herbage, yield, chemical composition.

INTRODUCTION

Pasture management for increased yield and nutrient profile must be intensified to meet the forage need of

ruminants for the rising demand by man for animal protein. *P. maximum* (var Ntchisi) a tufted perennial humid tropical grass that is grazed by ruminants has robust growth, high productivity, acceptability, palatability, comparative nutritiveness and persistence. Little wonder then

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that Olanite et al. (2002) reported that *P. maximum* species are notable forages for animal production in Southwestern Nigeria. The grass has flat, bright green leaves varying between 15 and 60 cm in length and 4 – 20 cm in width with 0.5 to 5 m in height. It can adapt to a rainfall range of 700 – 1700 mm/year and requiring well drained sandy-loam or clay loam soils for good establishment (Oyenuga, 1960; FAO, 1989; Okeagu, 1991). Large or medium sized cultivars of the grass are poor seed producers and are therefore established vegetatively. The pasture can be grazed or cut for hay. Animal production from the pasture is high and stocking rates of 2 - 3 heads per hectare can easily be supported on it (Okeagu, 1991). The grass can tolerate shade and fire but not capable of withstanding water logging or severe drought (FAO, 1975).

The dry matter and crude protein yields are high and largely depend on the level of nitrogen fertilizer applied. Johnson et al. (1968) reported that the total carbohydrates fraction of guinea grass increased slightly with maturity in all seasons. He reported a decrease in crude protein from 9.8 to 6.6% and crude fibre decreased from 32.1 to 39.4% as the grass matured from about 3 weeks to about 10 weeks of growth. Meissner and Esterhuysen (1993) reported that *P. maximum* hay has the following composition; 90 - 92% dry matter, 2.1 - 2.6% nitrogen, 8.9 - 9.5% ash, 51 - 55% NDF, and 26 - 31% ADF. Bamikole et al. (1998) reported that the chemical composition of guinea grass harvested at 6 weeks in g/100 g dry matter contained 0.99 N, 69.43 NDF, 89.5 DM, 0.39 Mg and 0.28 Ca. However, Adeleye and Fanoiki (1997) reported 1.063% Ca, 0.754% Mg and 3.075% K.

Preston and Leng (1987) reported that guinea grass is one of the highest yielding perennial crops in terms of total biomass production per unit area on efficiency of solar energy captured. Jack (1956) pointed out that the pH range at which minerals in the soil will be made available for plant uses are 6 - 8.5 for magnesium and calcium and 6 - 8 for potassium. Agboola and Ayodele (1983) reported a critical level of 2 - 2.6 cmol/kg for calcium, 0.01 - 0.15 cmol/kg for potassium and 0.26 cmol/kg for magnesium.

Cutting frequencies had been reported to increase herbage yields of some grass species including *Panicum* species (Dawe et al., 1972; Svejcar and Rittenhouse, 1982). Oyenuga et al. (1960) and Bamikole et al. (1998) reported that dry matter yields in unfertilized sole grass plot declined at a faster rate under regular cutting as the nutrient reserves of the land under cultivation were continually depleted. Declined nutritional quality had also been reported to be associated with cutting interval (Okwori, 1989). Cutting interval when intensified enhanced nutritive value but reduced dry matter yields and loss of stands (Mohammed-Saleem, 1972). In summary, up till now there are still divergent opinions on cutting frequencies that would match high dry matter yield with optimum quality.

While there were almost sufficient information on the usage of *P. maximum* in ruminant production, information is scanty on studies that investigated the usage of anhydrous magnesium sulphate fertilizer to increase yield and uptake of macrominerals such as magnesium, calcium and potassium. This study is therefore designed to investigate the effects of anhydrous magnesium sulphate fertilizer on *P. maximum* yield and the herbage nutrient concentrations.

MATERIALS AND METHODS

Site selection and experimental design

The experiment was conducted at the Teaching and Research Farm, University of Ibadan, South Western Nigeria. Physical and chemical properties of the soil in which the experimental grass was grown indicated pH 5.9, 1.04 cmol/kg total nitrogen, 0.52 cmol/kg exchangeable magnesium, 0.14 cmol/kg exchangeable potassium, 3.16 cmol/kg exchangeable calcium, 9.9 cmol/kg available phosphorus and the cation exchange capacity of 0.65 cmol/kg. Also it has 798 g/kg sand, 171 g/kg silt, 8 g/kg clay and 15.4 g/kg organic matter.

A monospecific pasture of guinea grass was planted on 0.576 hectare of land to investigate the effect of magnesium fertilization and interval of cutting. The fertilization on the *P. maximum* termed Treated and Untreated was studied against cutting intervals of 3, 4 and 5 weeks. This gave a 2 x 3 factorial arrangement in a randomized complete block with 3 plots per treatment. The 0.576 hectare of land was divided into 6 plots of 16 m x 24 m. Each plot was again subdivided into 4 sub-plots of 4 x 6 m with row spacing of 0.3 x 6 m. The rows were randomly allotted into six treatment groups (F_1C_1 , F_1C_2 , F_1C_3 , F_2C_1 , F_2C_2 , F_2C_3). Note $F_1 \neq F_2$ = states of fertilization and $C_1 \neq C_2 \neq C_3$ = cutting intervals and the treatment combinations were $F_1C_1 = T_1$ = fertilized at 3 weeks cutting interval; $F_1C_2 = T_2$ = fertilized at 4 weeks cutting interval; $F_1C_3 = T_3$ = fertilized at 5 weeks cutting interval; $F_2C_1 = T_4$ = unfertilized at 3 weeks cutting interval; $F_2C_2 = T_5$ = unfertilized at 4 weeks cutting interval; $F_2C_3 = T_6$ = unfertilized at 5 weeks cutting interval.

The statistical model is $Y_{ij} = \mu + T_i + C_j + \sum_{ij}$

Where Y_{ij} = individual observation, μ = general mean, T_i = effect of the i th block, C_j = effect of the j th treatment, and \sum_{ij} = experimental error.

The existing grass on each of the rows was cut back at a height of 10 cm to the ground level and allowed to recuperate for one week before treatment was imposed. Half of the rows were treated with magnesium fertilizer in the form of magnesium sulphate at a uniform rate of 200 kg ($MgSO_4 \cdot 7H_2O$) per hectare by top dressing method while the other half was not. The grass were harvested at 3, 4 and 5 weeks of growth for one growing season.

The dry matter yield and the macro minerals namely calcium, potassium and magnesium uptake of the grass were determined according to AOAC (1990).

Statistical analysis

Data from the experiment were analyzed using SAS (1999). The treatment means was significant and were separated using Duncan's multiple range test (1995).

RESULT AND THE DISCUSSION

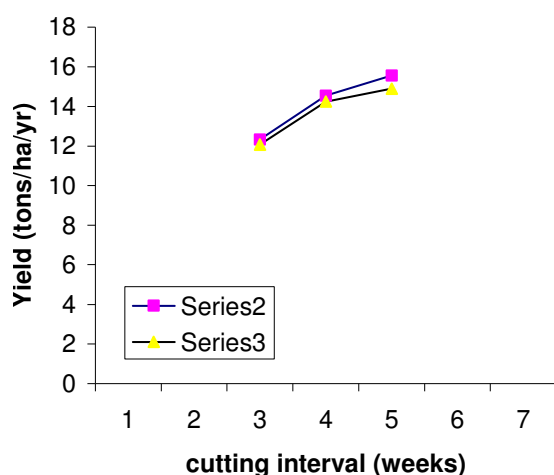
The results presented in Table 1 showed that there were

Table 1. Yield and chemical composition of treated and untreated *Panicum maximum*.

| Parameter | T ₁ | T ₂ | T ₃ | T ₄ | T ₅ | T ₆ | ±SEM |
|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|-------|
| DMYield (T/ha/yr) | 12.33 ^a | 14.54 ^b | 15.56 ^c | 12.07 ^a | 14.25 ^b | 14.89 ^{bc} | 0.262 |
| CP (%) | 8.04 ^a | 7.34 ^b | 6.68 ^a | 7.17 ^b | 7.18 ^b | 6.54 ^a | 0.000 |
| NDF (%) | 57.34 ^a | 71.24 ^e | 73.24 ^f | 6238 ^b | 65.24 ^c | 67.58 ^d | 0.592 |
| ADF (%) | 34.28 ^a | 36.24 ^b | 35.88 ^b | 41.22 ^c | 43.21 ^d | 45.24 ^e | 0.237 |
| Mg content (%) | 0.13 ^c | 0.10 ^b | 0.085 ^a | 0.08 ^a | 0.07 ^a | 0.06 ^a | 0.000 |
| Ca content (%) | 0.27 ^a | 0.31 ^b | 0.25 ^a | 0.33 ^b | 0.21 ^a | 0.37 ^b | 0.000 |
| K content (%) | 0.007 | 0.006 | 0.005 | 0.008 | 0.007 | 0.006 | 0.000 |

Letters lacking a common superscript within rows differ significantly ($P < 0.05$).

T₁ = fertilized at 3 weeks cutting interval; T₂ = fertilized at 4 weeks cutting interval; T₃ = fertilized at 5 weeks cutting interval; T₄ = unfertilized at 3 weeks cutting interval; T₅ = unfertilized at 4 weeks cutting interval; and T₆ = unfertilized at 5 weeks cutting interval.

**Figure 1.** Interaction between fertilizer application and cutting frequencies.

significant differences ($P < 0.05$) in dry matter yield between treated grass and the intervals of cuttings and also between the untreated grass and the interval of cuttings. Although, there was no significant difference ($P > 0.05$) between the treated and the untreated grass at the same cutting interval, there was a marginal increase with the treated showing superiority in all the cases. This marginal increase in yield might be as a result of the magnesium fertilizer being able to raise the magnesium level in the plant to a level sufficient for optimum growth and the effect of the fertilizer on the soil microorganisms. Other researchers had corroborated this marginal increase in herbage yield. Aitken et al. (1998), in his experiment with acidic soil, reported a marginal yield increase in grains. Also, Ridges et al. (1980) reported sugar cane yield increase when magnesium fertilizer was applied in Australia. Also observed was the increase in yield as the cutting interval increased in both cases of treated and untreated grass. This trend agrees with the works of Dawe et al. (1972), Svejcar and Rittenhouse (1982) and Bamikole et al. (1998) who reported dry matt-

er yield decline at a faster rate under regular cutting as the nutrient reserves of the land under cultivation were continually depleted as a result of repeated cuts thus depressing subsequent growth. This repeated cut was more intense in T₁ and T₄, hence the low yields. The result was also in accord with the work of Oyenuga (1960) when he reported annual dry matter yield of 12, 16, 15.2 and 23.4 tons per hectare in guinea grass plots at Ibadan when the grass was harvested at 3, 6, 8 and 12 weeks cutting intervals, respectively.

The marginal increase in the yield of the treated grass and the untreated is evident in Table 1 while Figure 1 showed the interaction between fertilizer application and cutting frequency with respect to treated and untreated *P. maximum*. From the figure, it was found that there was no interaction between fertilizer application and cutting frequency.

The crude protein contents of T₁, T₂ and T₃ representing the treated grass at cutting intervals of 3, 4 and 5 weeks, respectively, were significantly ($P < 0.05$) different (Table 1). The same trend was recorded in T₄, T₅ and T₆ representing the untreated grass at cutting intervals of 3, 4 and 5 weeks, respectively. At the equivalent cutting intervals between the treated and the untreated grass, the crude protein contents, though, not significantly ($P > 0.05$) different was consistently higher than that of the untreated. This might be as a result of the mineralization of $MgSO_4 \cdot 7H_2O$ by microorganisms in the soil and its mobilization thus enhancing magnesium and sulphur uptake and translocation of phosphorus all of which, particularly sulphur, play important role in protein synthesis. This reason corroborated the report of Klacan and Berger (1963) that magnesium sulphate fertilizer increased uptake of magnesium, sulphur, translocation of phosphorus and consequently its amino acid profile although in canning pea. The protein content of the grass declined as the plant aged. The reason for this could be attributed to the rapid growth rate of tropical grass and the rapid build-up of crude fibre and the encrustation of lignin in them as the plant matured noting that fibre and protein contents of forage are inversely related. This sug-

gestion is similar to the report of Johnson et al. (1968) who indicated that crude protein contents of forage decreased as the forage matured from 3 – 10 weeks of growth. Table 1 also showed that the NDF contents of T1, T2 and T3 representing the treated grass at cutting intervals of 3, 4 and 5 weeks, respectively, were significantly ($P < 0.05$) different. The same trend was recorded in T4, T5 and T6 representing the untreated grass at cutting intervals of 3, 4 and 5 weeks respectively. The NDF contents were higher in the untreated grass than the treated grass. The ADF in T4, T5 and T6, which were the untreated grass, were significantly different ($P < 0.05$). Although there was no definite pattern in the manner the ADF increased in the treated grass, it increased as the plant aged in the untreated grass. The NDF and the ADF constitute the fibre contents of the grass under study. The trend of increase of the crude fibre followed that of the crude protein, although, inversely. This was supported by the work of Uweh (1990) that lignifications increased with increased age of plants and Johnson et al. (1968) that total carbohydrate fraction of guinea grass increased with maturity in all season. The ADF constituent in the untreated grass was higher than the treated grass most probably because fertilization reduces the rapidity of lignifications in forage crops.

Table 1 also showed that the magnesium fractions of T1, T2 and T3 representing the treated grass at cutting intervals of 3, 4 and 5 weeks, respectively, were significantly ($P < 0.05$) different while those of T4, T5 and T6 representing the untreated grass at cutting intervals of 3, 4 and 5 weeks respectively were similar ($P > 0.05$). The magnesium fractions of T3 and those of the untreated *P. maximum* were also similar ($P > 0.05$). The herbage magnesium content between the treated and the untreated at the same cutting interval were different as the magnesium contents in treated grass were consistently higher than the untreated at the same cutting intervals. In the treated grass, the magnesium contents of the herbage grass did not show a definite pattern as the cutting interval increased but it did decrease in the untreated grass as the grass matured. The trend of higher magnesium content in treated grass than in the untreated suggested that the fertilizer applied could have enhanced magnesium uptake by the grass and the decrease as the plant matured might probably be because magnesium sulphate fertilizer release its constituents quickly with the remainder in the soil being leached away from week to week or due to a natural dilution process and translocation of nutrients to the root system (Humphreys, 1978; Bamikole et al., 1998).

The Calcium contents of treated grass at different cutting intervals were similar ($P > 0.05$) in T1 and T3 but different ($P < 0.05$) in T2. Similar trend was observed in the untreated grass T4, T5 and T6. The herbage calcium content seemed not to be influenced by magnesium fertilizer application. Also age at cutting seemed not to show effect on the herbage calcium content in both cases

of treated and untreated grasses. This result conforms to the report of McDowell et al. (1993) that unlike other minerals, forage calcium concentration was not affected by advancing age.

The potassium content of both the treated and untreated grass was similar ($P > 0.05$). In both the treated and the untreated grass, the potassium contents of the grass decreased with age. This corroborated the findings of Okwori (1989) that declining nutritional quality could be associated with cutting intervals.

Conclusion

It was concluded that magnesium fertilizer in form of $MgSO_4 \cdot 7H_2O$ increased the dry matter yield of guinea grass, the crude protein content, and the magnesium uptake of the grass. Cutting frequency was also found to influence yield, crude protein and crude fibre contents of guinea grass.

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