Effects of Varying Levels of Inorganic Fertilizer Application on the Underground and Nutritive Response of Panicum *maximum* cv. T58 (Guinea Grass)

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Abstract
A pot experiment was conducted at the pasture unit of Ladoke Akintola University of Technology Ogbomoso, Nigeria, Teaching and Research Farm, to study the effect of inorganic fertilizer application levels on the underground response of *Panicum maximum*. The varying levels were 0 (control), 50, 100 and 200kg/ha NPK 15:15:15. Four cutting frequencies at 4th, 8th, 12th and 16th weeks were done. It was observed that the shortest and longest root length in week 16 for the control treatment has the value of 3.63cm and 62.70cm respectively. At inclusion level of 50kg/ha (1.5g/pot), 100kg/ha (3g/pot) and 200kg/ha (6g/pot) there were significant differences ($P<0.05$) between root lengths and Biomass yield for the weeks examined. The root length and biomass yield were observed to increase as the week increased. The possible increase in root length will ascertain the potential of the plant to be able to draw up nutrient from the deep soil and also withstand possible adverse weather conditions. The interactive effect of varying levels of inorganic fertilizer application on the chemical composition of the plant at various weeks revealed an increase in the Dry Matter, Crude Protein and Ash content with increase in fertilizer level and age at harvest. At week 12 of 100kg/ha, values for the crude fibre decreased with increase in the level of fertilizer applied. The Ether Extract was inconsistent with application rate and age at harvest as the highest value (2.95%) was observed at week 12 with 200kg/ha (6g/pot).The potassium and phosphorus levels in the forages increased with increase in fertilizer and age at harvest. From the result it is evident that inorganic fertilizer application at varying levels and age at harvest has effect on the nutrient content of the root and biomass yield of *Panicum maximum.* The root length (shortest and longest) and biomass yield also increased significantly as levels of fertilizer application increased and with age of harvest. . Increase in biomass yield will ensure forage availability for ruminant animals.
Keywords: Panicum maximum, roots length, biomass yield.

1. Introduction

A highly productive pasture require improved soil conditions for increased dry matter (DM) yield towards increased animal output and this is usually met through fertilizer application (Chemist Justus von Liebig 1803-1883).Once applied, the fertilizer increases the quality/quantity of deficient element(John, 2006). Sodehinde *et al* (2006) observed that nitrogen fertilizer influenced positively the numbers of tillers produced per stand in an experiment on the effect of nitrogen on dry matter yield of *Panicum maximum*. The increased yield due to fertilizer application could be attributed to increase in both leaf production , increased number of tillers and photosynthesis directly(Aderinola *et al* ., 2011) Natural pasture grasses are wild and are characterized by low yield and poor nutrients (Babayemi and Bamikole 2006) as they grow on infertile and erosion degraded soils. Tropical grasses have ability for high yield and the nutrient are simultaneously enhanced when treated with organic/inorganic fertilizer or established with nitrogen fixing shrubs or tree legumes (Aderinola 2011). Crowder and Chheda (1982) reported that the annual dry yield from grasses is less than 0.5t/ha on the Arid Aristida natural grass land of sub Saharan to more than 100t/ha on heavily fertilized *Pennisetum purpureum* planted in humid low land tropics. Unfertilized grasses and those grown without legume companion had been described to be less nutritive as forage for goats (Bamikole and Babayemi 2004).

Panicum maximum, a valuable fodder plant in the area where it is distributed has high leaf and seed production and is very palatable to game and livestock. It is widely cultivated as pasture and is especially used to make good quality hay. If it receives adequate water, it grows rapidly and occurs in abundance in soils that is in a good condition.

Effects of fertilizer application on forage performance has always been based on the foliage yield and nutrient content , however the root is the medium through which all nutrients in the soil are transported to the shoot. Since most nutrients are absorbed by roots, understanding root characteristics is important in developing efficient nutrient management practices. Root system are usually either fibrous or tap and both occur with annuals, biennials or perennials. The root ability to exploit soil for water and nutrients depend on their morphological and physiological characteristics. This study therefore sought to know the effect of varying nitrogen fertilizer application on the performance of *Panicum maximum* and its roots.

2. Materials and Method

This study was conducted at the pasture unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Laid in a 4x4 factorial experimental design, Panicum *maximum* (cvT58) tillers cut to about 15cm was planted in 48 perforated pots containing 9g of sandy loamy soil each. Inorganic NPK fertilizer (15:15:15) at varying quantity of 0, 1.5, 3 and 6g/pot representing 0, 50, 100 and 200kg/hectare was applied at 4 days after planting. Stolons of Panicum *maximum* (cvT58) was carefully uprooted from the main stand thoroughly shake off soil and the roots gradually shake in a container containing water to remove and dissolve remaining soil off the roots. At planting, the shortest and longest root lengths were measured per pot with the aid of a measuring ruler. Also this was measured at the end of the 4^{th}, 8^{th}, 12^{th} and 16^{th} week of planting. The measurement was done with the aid of a meter rule.

Amount of fertilizer required per pot =

$$\frac{\text{Soil wt. X (Pot)kg}}{2\ \text{x}10^{6}\text{kg}} \quad \text{X} \quad \frac{\text{Rate of fertilizer}}{\text{Conc. of nutrient}} \quad \text{X} \quad \frac{100}{1}$$

Treatment 1 =
$$\frac{9 \text{ x } 1}{2\ \text{x}10^{6}\text{kg}} \quad \text{X} \quad \frac{0}{15} \quad \text{X} \quad \frac{100}{1} \quad = 0\text{g/pot}$$

Treatment 2 =
$$\frac{9 \text{ x } 1}{2\ \text{x}10^{6}\text{kg}} \quad \text{X} \quad \frac{50}{15} \quad \text{X} \quad \frac{100}{1} \quad = 1.5\text{g/pot}$$

Treatment 3 =
$$\frac{9 \text{ x } 1}{2\ \text{x}10^{6}\text{kg}} \quad \text{X} \quad \frac{100}{15} \quad \text{X} \quad \frac{100}{1} \quad = 3\text{g/pot}$$

Treatment 4 =
$$\frac{9 \text{ x } 1}{2\ \text{x}10^{6}\text{kg}} \quad \text{X} \quad \frac{200}{15} \quad \text{X} \quad \frac{100}{1} \quad = 6\text{g/pot}$$

Source- Dalzel *et al* (1979)

Forage sample was collected at the end of the 4^{th}, 8^{th}, 12^{th} and 16^{th} week of each fertilizer level. At each week, the root length (longest and shortest) was measured with the aid of a measuring ruler. The experimental pot was broken and the soil let off, to prevent the roots from being cut. The weight of the root was measured after a thorough shaking off of the sands oven dried to a constant weight at a temperature of 70 ^{0}C. The biomass yield was measured with the aid of a weighing scale.

Sample collected at each week were taken to the laboratory for chemical composition of the root and foliage according to AOAC (2000) method. All data collected were subjected to statistical analysis of variance of SAS (1999) computer package. Differences between means were separated using Duncan Multiple Range F-Test of the same software.

3. Results and Discussion

The interactive effect of varying levels of inorganic fertilizer application and age at harvest on the initial, final root length, root weight and Biomass yield of *Panicum maximum* is as shown in table 1. The average initial root length (shortest and longest) was 0-53cm and 8.43cm respectively in the control treatment; 1.36cm and 16.13cm in treatment 2; 1.03cm and 14.96 cm in treatment 3 and 1.66cm and 14.93cm in treatment 4. These were observed to increase with age and fertilizer application. The shortest and longest root length in week 16 for the control treatment has value of 3.63cm and 62.70cm respectively. However the longest root length among all the treatment was observed in Treatment 3 (79.5cm). Increase in root length with increasing age of plant and with/without fertilizer application was observed in all the treatments. This is in agreement with the work of Rasmussen, *et al*., (1996) that observed increase in biomass yield and root length as plant ages. Increase in biomass yield will ensure forage availability for the ruminant animals and increase in root length will ensure that more nutrients are being absorbed from the depth of the soil with might not be available at the upper layer of the soil and will also increase the drought resistance of a plant.

The average final longest root length was observed to be inconsistent among treatments, generally higher values was observed in treatment 2 and 3 and lower values in treatment 1 and 4. The lower values observed in the control (treatment 1) might be due to non application of fertilizer. Low values were observed in week 16 at the application of 6g fertilizer. This may be due to non availability of space for root elongation. The highest root weight was observed in this treatment. Increase in root weight was observed to increase with age and fertilizer application. Biomass yield was observed to increase with fertilizer application and age. There was a positive correlation between the biomass yield and weight of the roots. It revealed that agronomic parameters increased with week and responded well to fertilization. Aderinola, *et al.,* (2009) reported higher values for forage biomass yield from fertilized soil than from forages growing on unfertilized soil.

The interactive effect of varying levels of inorganic fertilizer application on the chemical composition of the forage plant is as shown in table 2.

There were significant changes in the crude protein content of the forages. It increases with increase in fertilizer level and age at harvest. The increase in crude protein observed could have been due to increase in the level of inorganic fertilizer applied. This is in agreement with the report of Aderinola *et al*, (2011) who reported that the crude protein content increase in forages with the addition of fertilizer.

All the crude fibre decreased with increase in the level of fertilizer applied except in week 12 where there was highest increase with inclusion level of 100kg/ha (3g/pot). This agrees with the findings of Aderinola *et al,* (2011) that crude fibre content of *Andropogon tectorum* grass decreases with increasing fertilizer application level. Forages that have the availability of nitrogen will have the tendency of increasing growth rate, thus reducing the lignifications of the plant materials.

All the ash content was observed to increase with increase in age and fertilizer applied. This is in contrast with the work of Gomide (1978) who reported that mineral concentration decline with age in tropical forage, but in agreement with the work of Aderinola *et al*, (2011) that reported increase in the ash content of *Andropogon tectorum* with age and increased fertilizer application respectively.

The Ether Extract was inconsistent with application rate and age at harvest as the highest value was observed at week 12 with 200kg/ha (6g/pot). The Nitrogen Free Extract decreased with increase in fertilizer level applied and age at harvest however the Dry Matter increased with increase in fertilizer level applied and age at harvest.

The potassium level increased with increase in fertilizer and age at harvest. This agrees with the finding of Galloway and Cowling, (2002) who observed that Nitrogen, Potassium and Phosphorus contributed satisfactorily to plant growth and were utilized well by grass.

The phosphorus level also increased as the grass ages and with increase in fertilizer applied. This agrees with the previous work of Galloway and Cowling, (2002) who reported that phosphorus at any planting period is always released in excess of its requirement for the next plant. Phosphorus helps in seed herbage production. Except for ether extract content of the root that shows inconsistency with increasing level of nitrogen fertilizer application across the age, the CP, ASH, P and K was observed to be increasing with increase in N fertilizer application, (Table 3).

From the result it was evident that inorganic fertilizer application at varying levels and age at harvest has effect on the nutrient content of the root and biomass yield of *Panicum maximum.* It could also be observed that there is positive relationship between the root length, root weight, and biomass yield of forage plants. It is recommended that inorganic fertilizer application at 200kg/ha favours the nutrients content and agronomic performance of guinea grass irrespective of the age.

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TABLE 1: Interactive effect of varying levels of fertilizer application and age at harvest on root length, biomass yield and root weight of *Panicum maximum*

	0g	1.5g	3g	6g	Sem
Week 4					
AIRL S (cm)	0.53^d	1.36^b	1.03^c	1.66^a	0.128
AIRL L (cm)	8.43^c	16.13^a	14.96^b	14.93^b	0.914
AFRL S (cm)	1.83^b	2.60^a	1.66^c	1.56^c	0.125
AFRLL (cm)	27.86^c	42.20^a	28.33^b	21.50^d	2.279
ABY (g/pot)	90.0^c	90.3^b	126.3^a	63.0^d	6.781
ARW (g/pot)	81.6^a	56.6^c	76.0^b	26.6^d	6.483
Week 8					
AFRL S (cm)	2.20^b	2.30^b	1.50^c	2.96^a	0.157
AFRLL (cm)	52.00^c	63.53^a	62.60^b	48.50^d	1.970
ABY (g/pot)	131.5^d	726.1^b	418.5^c	857.5^a	84.866
ARW (g/pot)	86.5^d	228.0^a	193.0^c	194.5^b	16.057
Week 12					
AFRL S (cm)	2.26^c	3.45^b	3.50^b	3.70^a	0.172
AFRLL (cm)	55.40^d	68.1^b	70.20^a	60.25^c	1.798
ABY (g/pot)	280.0^d	720.0^c	1203.3^b	1586.6^a	148.569
ARW (g/pot)	83.0^d	253.3^c	430.0^a	363.3^b	39.582
Week 16					
AFRL S (cm)	3.63^d	5.10^a	3.93^c	4.40^b	0.168
AFRLL (cm)	62.70^c	75.5^b	79.5^a	60.56^d	2.441
ABY F (g/pot)	466.6^d	1070.0^c	1490.0^b	2430.0^a	215.533
ARW (g/pot)	236.6^d	330.0^c	476.6^b	1180.0^a	111.679

AIRL S = Average Initial Root length (Shortest)
AIRL L = Average Initial Root length (Longest)
AFRL S = Average Final Root length (Shortest)
AFRL L = Average Final Root length (Longest)
ABY F = Average Biomass Yield
ARW = Average Root Weight

TABLE 2: Interactive effect of varying levels of inorganic fertilizer application and age at harvest on chemical composition of *Panicum maximum* forage

	0g	1.5g	3g	6g	Sem
Week 4					
CP	7.76^{d}	8.13^{c}	9.79^{a}	9.67^{b}	0.276
CF	37.71^{a}	37.56^{b}	31.35^{c}	31.23^{d}	0.958
ASH	7.21^{d}	7.28^{c}	8.89^{b}	8.95^{a}	0.257
EE	2.67^{b}	2.43^{c}	2.74^{a}	2.38^{d}	0.064
NFE	44.80^{ab}	44.52^{ab}	40.56^{b}	47.77^{a}	0.774
DM	91.36^{d}	91.55^{b}	91.44^{c}	91.63^{a}	0.054
P	0.57^{c}	0.63^{b}	0.86^{a}	0.63^{b}	0.056
K	0.26^{d}	0.35^{c}	0.56^{b}	0.67^{a}	0.662
Week 8					
CP	9.89^{d}	9.97^{c}	10.37^{b}	10.69^{a}	0.107
CF	37.85^{a}	37.63^{b}	37.31^{c}	35.83^{d}	0.242
ASH	9.18^{d}	9.27^{c}	10.38^{b}	10.59^{a}	0.200
EE	2.79^{c}	2.88^{b}	2.83^{c}	2.94^{a}	0.048
NFE	40.29^{b}	40.25^{b}	40.44^{a}	39.94^{c}	0.071
DM	92.15^{d}	92.78^{b}	92.39^{c}	92.89^{a}	0.101
P	0.94^{b}	1.33^{a}	1.29^{a}	1.38^{a}	0.069
K	0.69^{ab}	0.76^{ab}	0.89^{a}	0.64^{b}	0.053
Week 12					
CP	10.13^{d}	10.37^{c}	11.29^{b}	11.68^{a}	0.198
CF	37.88^{b}	36.34^{c}	38.29^{a}	36.13^{d}	0.287
ASH	10.25^{d}	10.53^{c}	11.67^{b}	12.14^{a}	0.240
EE	2.71^{d}	2.84^{b}	2.77^{c}	2-95^{a}	0.083
NFE	40.60^{a}	39.64^{b}	35.98^{c}	34.80^{d}	0.733
DM	92.74^{b}	92.29^{c}	92.76^{b}	93.23^{a}	0.110
P	1.13^{d}	1.18^{c}	1.65^{b}	1.79^{a}	0.097
K	0.78^{d}	0.89^{c}	0.97^{b}	1.15^{a}	0.060
Week 16					
CP	10.65^{c}	10.66^{c}	11.46^{b}	11.89^{a}	0.166
CF	38.23^{a}	37.94^{b}	36.56^{c}	36.48^{d}	0.242
ASH	10.49^{d}	10.67^{c}	11.82^{b}	13.23^{a}	0.333
EE	2.69^{d}	2.83^{b}	2.79^{c}	2.94^{a}	0.087
NFE	37.82^{a}	37.73^{b}	37.25^{c}	34.94^{d}	0.356
DM	92.69^{b}	92.77^{b}	93.53^{b}	95.69^{a}	0.368
P	1.32^{d}	1.41^{c}	1.88^{b}	1.93^{a}	0.093
K	0.89^{d}	1.09^{c}	1.23^{b}	1.34^{a}	0.067

TABLE 3: Interactive effect of varying levels of inorganic fertilizer application and age at harvest on chemical composition of the root of *Panicum maximum*

	0g	1.5g	3g	6g	Sem
Week 4					
CP	3.37^c	3.46^c	4.29^b	4.57^a	0.176
CF	13.69^a	13.74^a	11.54^b	11.47^b	0.343
ASH	2.18^b	2.23^b	2.47^a	2.56^a	0.944
EE	1.97^b	1.62^c	2.08^a	1.55^c	0.106
NFE	78.59^c	78.95^b	79.62^a	79.85^a	0.173
DM	91.16^a	90.88^b	91.22^a	90.95^b	0.917
P	0.52^b	0.58^b	0.71^a	0.72^a	0.085
K	5.68^a	5.97^a	6.52^a	9.97^a	0.525
Week 8					
CP	4.48^d	4.73^c	5.67^b	6.34^a	0.239
CF	15.54^a	15.46^a	14.03^a	13.82^a	0.252
ASH	2.69^c	2.79^b	3.18^a	3.26^a	0.110
EE	2.05^c	2.23^b	2.09^c	2.64^a	0.108
NFE	75.24^a	74.79^b	74.03^d	74.27^c	0.163
DM	90.83^c	91.49^a	91.07^b	91.57^a	0.122
P	0.87^d	1.01^c	1.16^b	1.39^a	0.100
K	6.98^d	7.13^c	7.69^b	7.89^a	0.140
Week 12					
CP	5.13^d	5.49^c	6.59^b	6.96^a	0.242
CF	15.76^a	15.69^a	14.15^b	13.17^c	0.338
ASH	2.84^c	3.01^b	3.49^a	3.58^a	0.124
EE	2.11^c	2.37^b	2.18^c	2.56^a	0.097
NFE	74.06^a	73.48^d	73.59^c	73.73^b	0.105
DM	90.97^d	91.57^b	91.23^c	91.74^a	0.117
P	0.98^d	1.16^c	1.37^b	1.59^a	0.106
K	7.13^d	7.34^c	7.96^b	8.07^a	0.145
Week 16					
CP	5.59^c	5.67^c	6.74^b	7.15^a	0.218
CF	15.94^a	15.77^a	14.23^b	14.29^b	0.255
ASH	2.92^d	3.11^c	3.58^b	3.79^a	0.133
EE	2.11^d	2.32^c	2.21^c	2.62^a	0.100
NFE	73.46^a	73.13^c	73.24^b	72.33^d	0.152
DM	91.66^c	92.07^a	91.86^b	92.08^a	0.096
P	1.07^d	1.38^c	1.53^b	1.69^a	0.107
K	7.55^d	7.65^c	8.06^b	8.19^a	0.115