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Effects of organic mulch on soil fertility: a comparison study using leafy biomass from tree species

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ABSTRACT: One of the major challenges of the developing countries is the production of sufficient food for the rapidly increasing population and over cultivation of land resulting in soil infertility. Hence, the transfer of nutrients through tree biomass contribute to micro variability in soil fertility and plant growth. A field experiment was conducted in the forest nursery of the Federal University of Agriculture, Abeokuta (FUNAAB) Nigeria, to investigate the fertility of tropical lowland soil after the application of pruned leafy biomass of these agroforestry tree species; *Anogeissus leiocarpus, Enterolobium cyclocarpum, Gliricidia sepium, Leucaena leucocephala* and *Treculia africana*, which were incorporated into the soil at the rate of 5 tons per hectare (5000 kg ha^{-1}). The soil samples were collected at 2, 4, 6, 8 and 10 weeks after application. Split plot experimental design was used with the time of soil sampling as the main plots, with mulch type as sub-plots. Data were analysed using Analysis of Variance (ANOVA) on pH, organic carbon (OC), total nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na). *L. leucocephala* had the highest nutrient release values (0.19 g kg^{-1}, 41.07 mg kg^{-1} and 139.00 mg kg^{-1}) on N, Ca and Na respectively. However, *E. cyclocarpum* also had highest nutrient contents (94.00 mg kg^{-1} and 152.50 mg kg^{-1}) in both K and Mg. Soil nutrient content with collection days revealed that pH and OC had significant higher values (6.43 and 31.30 g kg^{-1}) on days 84 and 28. N experienced higher value (0.16 g kg^{-1}) both on days 28 and 42. Meanwhile, Ca and Na had their peak values (37.75 mg kg^{-1} and 130.83 mg kg^{-1}) on day 42. *L. leucocephala* and *E. cyclocarpum* were observed to have significant higher values (39.10 g kg^{-1}, 0.28 g kg^{-1}, 54.00 mg kg^{-1} and 115.00 mg kg^{-1} and 219.50 mg kg^{-1}) in soil nutrient content with respect to days and species on OC, N, Ca and K and Mg on days 84, 28, 28 and 14 and 28 respectively. It is concluded that *L. leucocephala* had a fast decomposition and nutrient release rate among others which makes it a good alternative organic material for improving soil nutrients in lowland tropical soils. It is therefore recommended as a better organic resource material for soil improvement strategies.

Introduction

Most soils in the tropics are deficient in soil nitrogen (N), phosphorus (P), or both and even organic carbon (OC) (Sanchez and Logan, 1992; Pandey et al. 2006). Many of the tropical soils are acidic, infertile and cannot support sustainable crop production without external inputs of fertilizers due to continuous cropping system. To some up, some soils which were once fertile have become depleted and can no longer sustain crop production (Manfongoya et al. 1998; Oyebamiji et al. 2017). Such fertilizers, which are inorganic in form, are not readily available to farmers. Sometimes, when available, they are being sold at exorbitant prices.

The high population pressure on land and the shortened fallow period have made it difficult to increase and sustain food production on the infertile soils of the tropics (Kang, 1993; Oke, 2005). Consequently, the issue of biomass transfer has been noted as alternative method to improve soil fertility (Oke, 2005).

The use of plant biomass has sparked interest in the productivity improvement of agricultural crops. However, the amount and kind of nutrients released and thus added to the soil depends on the composition of the added plant biomass. The transfer of nutrient through tree biomass can contribute to micro variability in soil fertility and plant growth (Brouwer et al. 1993). According to Manfongoya et al. (1998), the potentials of tree biomass to supply nutrient on their resource quality is based on the quality of the organic material present, the environment and the type of organism present, that influence decomposition and nutrient release. Salako and Tian (2001) also emphasized that the efficient conversion of plant biomass to humus by soil organisms largely depends on climatic factors and the plant tissue quality.

Agroforestry systems are viable and sustainable land use alternatives, because of the benefits of trees in maintaining soil fertility. Trees maintain and enhance soil fertility by adding nitrogen through fixation, recycling nutrients through litter fall or pruning, or importing nutrients through biomass transfer systems (Oyebamiji et al. 2016). The nutrients released therefore are made available to crops through the decomposition of the tree pruning and litter (Manfongoya et al. 1998). Soil organic residues such as leaves, twigs, reproductive parts, bark, and wood, roots and dead bodies of animals can serve as humus for soil amendments (Wanek et al. 2008; Alfredo, 2015). In this work, the use of leafy biomass of some selected agroforestry tree species (*Anogeissus leiocarpus, Enterolobium cyclocarpum, Gliricidia sepium, Leucaena leucocephala* and *Treculia africana*, which are leguminous in nature, that is, having ability to fix nitrogen into the soil) were tested. Verifying if they improved soil and if they changed nutrients as influenced by leafy biomass when incorporated into the soil were the specific objectives of the study.

Material and Methods

Study area

The experimental site was Federal University of Agriculture, Abeokuta forest nursery. The site is located between the latitudes of 7° N and 7° 58' N and the longitudes of 3° 20' E and 3°27' E, at 600 m above the ground level. The general topography of the site is undulating while the local topography an upper mid-slope. The geology and soil of the area are under laid by the pre-cambium metamorphic rocks of the basement complex with bedrock consisting predominantly of gentle gneisses, bounded biotite, quartzite, and quartz schists. The soil is a fertile sandy loam, very dark at the top surface and grayish brown in the subsoil with occasional areas of loamy soil and the landscape is a slope. Meanwhile, the climate of the area has a tropical climate with a binomial distribution of rainfall. It lies within the humid lowland region with two distinct seasons. The wet season extends from April to October, while the dry season extends from November to March. The mean annual rainfall is 1113.1 mm. The bimodal distribution of rainfall has its peak in July and September and breaks in August. Generally, the rainfall could be heavy and sometimes accompanied by lightning and thunderstorm at the beginning and end of the season. This heavy rainfall could cause erosion. The mean monthly temperature varies from 22.74^0 C in August to 36.32^0 C in March. The relative humidity is high, ranging from 75.52 % in February to 88.15 % in July (Aiboni, 2001).

Experimental design

The experimental design used was a split plot design with the main plots being the time of soil sampling, and the sub-plots were the mulch type sited in the forest nursery. An area of 10 m x 10 m was partitioned into 24 micro-plots of 1.5 m x 1.5 m dimension. Adjacent micro-plots were separated by a buffer of 0.25 m wide. Six (6) treatments; which include biomass were randomly applied to the plots including the control with four (4) replicates.

Mature but not senescent leaves were carefully selected from the woody species of *L. leucocephala, T. africana, E. cyclocarpum, A. leocarpus, G. sepium*, and were pruned for mulch. Each of the treatments were applied at the rate of 5 tons per hectare (5t ha^{-1}), meaning that 5 kg from each species were applied 1.5 m x 1.5 m micro-plots assigned to the species which were randomly selected.

Soil Sampling

Surface soil (0-15 cm) samples were collected at three auger points. The three auger points were taken in each of the micro-plots and then bulked to homogenize. The soil samples from each micro-plot were collected at 2, 4, 6, 8 and 10 weeks after application (WAP) and then taken to the laboratory for analysis.

Soil and statistical analysis

Soil pH was measured with an electronic pH meter in a 1: 2.5 soil/water suspension. Soil organic carbon was determined by wet oxidation. Total nitrogen in the soil was determined using semi micro Kjeldahl method. Soil samples were leached with ammonium acetate solution to obtain the extracts used in the determination of exchangeable cations. Calcium and magnesium in the leachate were determined by Ethylene Tetra-acetic Acid (EDTA) titration while potassium was determined by flame photometry following the procedure of Oke (2005). Data were analyzed using the General Linear Model of SAS software (SAS, 2003), using two-way Analysis of Variance (ANOVA) and Duncan's Multiple Range Test was used to distinguish means ($p < 0.05$).

Results

Nutrient content of soil as affected by various leafy biomass application treatments

Results from the nutrient content analysis showed that there was a noticeable change in nutrient status as well as the application of the leafy biomass of the selected agroforestry tree species (Table 1). The pH value varies with species; meanwhile, control had significant higher value (6.45) compared with other treatments (*A. leocarpus*, *E. cyclocarpum, G. sepium* and *T. africana*) respectively. *G. sepium* was noted to have the least pH value (6.23). Organic carbon content also varied with species; control also had higher significant value (31.20 g kg^{-1}) among the others. Total nitrogen content for species revealed that *L. leucocephala* had significant higher value (0.19 g kg^{-1}) in comparison to the others. However, phosphorous content was not significant among the species as well as the control though it was the highest in *T. africana* (466.60 mg kg^{-1}) and the least was recorded in *E. cyclocarpum* (47.40 mg kg^{-1}).

Moreover, potassium and magnesium contents in relation to other species showed that *E. cyclocarpum* had significant higher values (94.00 mg kg^{-1} and 152.50 mg kg^{-1}) among other treatments, respectively. *L. leucocephala* showed significant higher values (41.07 mg kg^{-1} and 139.00 mg kg^{-1}) in calcium and sodium, respectively, than the other treatments (Table 1).

Soil nutrient content with varying days of collection

Soil nutrient content with varying days of collection revealed that pH and organic carbon had significant higher values (6.43 and 31.10 g kg^{-1}) respectively on day 84 than other days, and also organic carbon was significant on day 28 with significant value of 31.30 g kg^{-1}. Total nitrogen content was significant on 28 days (0.16 g kg^{-1}) and day 42 (0.16 g kg^{-1}), respectively. Phosphorus content was not significant across the various days of collection. Potassium content was significant on day 14 with higher value (71.67 mg kg^{-1}) and day 42 (67.50 mg kg^{-1}), respectively. Moreover, calcium and sodium contents showed significant higher values (37.75 mg kg^{-1} and 130.83 mg kg^{-1}) respectively on day 42 among other treatments. Meanwhile, magnesium content was not significant across the various days of collection (Table 2).

Nutrient content of soil varying with days and species

The pH and organic carbon with day of collection and species experienced variation as control and *L. leucocephala* had significantly higher values (6.62 and 3.91 g kg^{-1}) at day 84, respectively, among other treatments. Total nitrogen and calcium contents had significantly higher values (0.028 g kg^{-1} and 54.00 mg kg^{-1}) in *L. leucocephala* and magnesium (219.50 mg kg^{-1}) in *E. cyclocarpum* species on day 28, respectively. However, phosphorous had significantly higher value (1983.2 mg kg^{-1}) in *T. africana* on day 42. Furthermore, potassium and sodium contents also had significantly higher values (115.00 mg kg^{-1} and 355.00 mg kg^{-1}) in *E. cyclocarpum* and *L. leucocephala* on day 14 respectively (Table 3).

Discussion

There were changes in nutrient status following the application of leafy biomass of *A. leocarpus*, *E. cyclocarpum, G. sepium, L. leucocephala* and *T. africana*. Control and *A. leocarpus* mulch plots were noted to have a higher pH than the others. This could be possible due to the effect of mulch materials which tend to improve soil exchangeable bases, thereby reducing soil acidity (Egbe et al. 2012).

L. leucocephala had the highest organic content value due to organic carbon accumulation in the herbaceous mulch plots because of the decomposition process of the leaves (Awopegba et al. 2017; Oladoye et al. 2019). On the other hand, the presence of nutrients and organic carbon in residual form might also be a likely factor. This is in agreement with Tejeda et al. (2007) and Awopegba et al. (2017) who reported that the application of leguminous residue had a positive effect on soil physical, chemical and biological properties and could be considered as a good alternative for improving low nutrient soils.

L. leucocephala plots also had the highest nitrogen, calcium and sodium contents due to its ability to fix nitrogen more rapid through decomposition and its greater N recovery when incorporated into the soil (Pandey et al. 2006; Oyebamiji et al. 2016; Awopegba et al. 2017; Kumar et al. 2017). *E. cyclocarpum* was observed to have the highest potassium and magnesium contents due

Table 1. Nutrient content of soil varying with leafy biomass species

Species	***A. leocarpus***	***E. cyclocarpum***	***G. sepium***	***L. leucocephala***	***T. africana***	**Control**
pH	6.37±0.04^{b}	6.34±0.03^{b}	6.23±0.04^{c}	6.25±0.05^{c}	6.26±0.04^{c}	6.45±0.03^{a}
OC (g kg^{-1})	30.40±0.05^{c}	29.30±0.03^{e}	27.00±0.07^{f}	30.50±0.12^{b}	29.60±0.02^{d}	31.20±0.07^{a}
Total N (g kg^{-1})	0.15±0.00^{b}	0.15±0.00^{b}	0.16±0.00^{b}	0.19±0.00^{a}	0.15±0.00^{b}	0.13±0.00^{c}
P (mg kg^{-1})	116.50±22.01^{a}	47.40±1.58^{a}	89.50±11.37^{a}	88.40±16.63^{a}	466.60±383.40^{a}	168.50±28.57^{a}
K (mg kg^{-1})	53.00±4.75^{c}	94.00±4.79^{a}	63.00±3.44^{b}	58.00±4.57^{bc}	56.00±2.40b^{c}	40.00±2.63^{d}
Ca (mg kg^{-1})	30.30±4.53^{bc}	25.20±2.81^{c}	28.60±3.14^{bc}	41.07±3.75^{a}	34.30±2.70^{b}	23.80±2.51^{c}
Mg (mg kg^{-1})	88.70±17.50^{b}	152.50±24.56^{a}	111.30±13.41^{ab}	95.50±17.37^{b}	105.20±20.19^{ab}	101.40±19.58^{ab}
Na (mg kg^{-1})	80.00±2.85^{abc}	62.00±4.41^{c}	82.00±3.00^{abc}	139.00±36.93^{a}	73.00±3.039^{bc}	132.00±45.70^{ab}

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5 % level of probability using DMRT

OC: Organic Carbon; **N:** Nitrogen; **P:** Phosphorus; **K:** Potassium; **Ca:** Calcium; **Mg:** Magnesium; **Na:** Sodium

Table 2. Nutrient content of soil varying with day

Day	**14**	**28**	**42**	**56**	**84**
pH	6.24±0.04^{c}	6.32±0.04^{b}	6.22±0.03^{c}	6.37±0.02^{ab}	6.43±0.04^{a}
OC (g kg^{-1})	29.50±0.03^{c}	31.30±0.02^{a}	27.80±0.06^{e}	28.50±0.05^{d}	31.10±0.09^{b}
Total N (g kg^{-1})	0.15±0.00^{ab}	0.16±0.00^{a}	0.16±0.00^{a}	0.14±0.00^{b}	0.15±0.00^{ab}
P (mg kg^{-1})	114.30±19.88^{a}	82.00±11.86^{a}	437.70±318.5^{a}	93.40±93.43^{a}	86.60±86.63^{a}
K (mg kg^{-1})	71.67±5.54^{a}	60.83±5.31^{b}	67.50±4.88^{a}	57.50±4.03^{b}	45.83±4.47^{b}
Ca (mg kg^{-1})	26.92±3.22^{b}	26.33±3.72^{b}	37.75±1.84^{a}	29.67±3.65^{b}	36.06±3.04^{ab}
Mg(mg kg^{-1})	119.08±16.93^{a}	93.85±16.14^{a}	127.92±21.48^{a}	120.17±17.24^{a}	84.75±15.33^{a}
Na (mg kg^{-1})	119.17±31.83^{ab}	75.83±2.78^{ab}	130.83±37.70^{a}	77.50±3.36^{ab}	70.00±3.66^{b}

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5 % level of probability using DMRT. **OC:** Organic Carbon; **N:** Nitrogen; **P:** Phosphorus; **K:** Potassium; **Ca:** Calcium; **Mg:** Magnesium; **Na:** Sodium.

to its ability to conserve soil moisture, increase soil organic matter, and improve soil properties and microbial activity thereby enhancing mineralization rate and release of nutrient into the soil (Kumar et al. 2017; Awopegba et al. 2017). Consequently, *L. leucocephala* and *E. cyclocarpum* supplied higher organic carbon, total nitrogen, potassium, calcium, magnesium, and sodium to the soil (Oladoye et al. 2019).

The soil pH increases steadily from day 14 through day 84. However, there was a decrease on day 42, which could be a result of heavy rainfall at that time. The result toed in line with Hailin Zhang (2013), who emphasized that certain factors could cause a rise in soil pH value which could be organic matter decay, harvest of high yielding crops, nitrification of ammonium, rainfall and leaching. Organic carbon was at its peak on day 28 after which it presented irregular fluctuating values which could be attributed to the rainfall pattern, causing it to be leached as they are released by the leguminous mulch species. Total nitrogen equally showed its highest values on days 28 and 42; meanwhile it was the lowest on day 56 and then higher on day 84. This could happen because of soil N concentrations caused by changes in temperature and moisture (Horneck et al. 2011).

Phosphorus content was at its peak on day 42, observing fluctuation both on days 14 and 28. This fluctuation might be due to the rainfall pattern concerning P release. This is in agreement with Horneck et al. (2011) who reported that phosphorus availability decreases in cool, wet soils. Potassium content was highest on day 14, due to rainfall patterns that stimulate the activities of microbes and

Table 3. Nutrient content of soil varying with days and species

Day/Species	**pH**	**OC (g kg^{-1})**	**Total N (g kg^{-1})**	**P (mg kg^{-1})**	**K (mg kg^{-1})**	**Ca (mg kg^{-1})**	**Mg (mg kg^{-1})**	**Na (mg kg^{-1})**
14 *A. leocarpus*	6.34±0.064^{b-f}	31.10±0.000^{f}	0.18±0.000^{de}	277.30±0.07^{b}	55.00±8.66^{efg}	14.00±2.89^{i}	92.50±11.258^{a-e}	80.0±0.000^{b}
14 *E. cyclocarpum*	6.24±0.012^{d-h}	29.10±0.000^{m}	0.11±0.000^{gh}	49.90±2.83^{b}	115.00±2.89^{a}	35.50±7.22^{a-g}	92.50±44.167^{a-e}	65.0±2.887^{b}
14 *G. sepium*	6.17±0.052^{e-h}	27.70±0.000^{r}	0.23±0.001^{bc}	116.00±36.96^{b}	70.00±5.77^{cde}	18.50±1.44^{i}	118.00±43.301^{a-e}	85.00±2.887^{b}
14 *L. leucocephala*	6.05±0.139^{h}	28.70±0.000^{o}	0.14±0.000^{efg}	48.00±2.03^{b}	70.00±11.55^{cde}	27.00±4.04^{c-i}	148.50±59.756^{a-d}	355.00±152.998^{a}
14 *T. africana*	6.27±0.000^{c-g}	30.70±0.000^{g}	0.14±0.000^{efg}	123.20±15.16^{b}	70.00±0.00^{cde}	46.00±0.58^{ab}	114.00±21.362^{a-e}	80.00±50.774^{b}
14 C**ontrol**	6.38±0.043^{bcd}	29.90±0.035^{k}	0.12±0.001^{fg}	71.50±0.59^{b}	50.00±0.00^{fgh}	16.50±3.75^{i}	149.00±71.014^{a-d}	70.00±11.547^{b}
28 *A. leocarpus*	6.52±0.015^{ab}	33.10±0.000^{b}	0.14±0.000e^{fg}	62.00±5.94^{b}	55.00±2.89^{efg}	24.00±8.66^{e-i}	44.00±14.434^{cde}	85.00±2.887^{b}
28 *E. cyclocarpum*	6.31±0.012^{c-g}	30.10±0.000^{j}	0.07±0.000^{h}	43.10±0.03^{b}	100.00±5.77^{ab}	22.50±4.33^{f-i}	219.50±32.620^{a}	75.00±2.887^{b}
28 *G. sepium*	6.06±0.066^{h}	30.50±0.000^{h}	0.25±0.000^{b}	59.00±7.30^{b}	45.00±2.89^{f-i}	17.50±2.60^{i}	94.00±2.309^{a-e}	70.00±0.000^{b}
28 *L. leucocephala*	6.40±0.012^{bcd}	31.10±0.000^{f}	0.28±0.000^{a}	73.10±0.63^{b}	75.00±2.89^{cd}	54.00±1.73^{a}	72.50±34.930^{b-e}	90.00±0.000^{b}
28 *T. africana*	6.26±0.046^{c-g}	31.30±0.000^{e}	0.14±0.000^{efg}	88.10±26.13^{b}	55.00±2.89^{efg}	26.00±9.24^{d-i}	29.50±22.805^{b-e}	65.00±2.887^{b}
28 **Control**	6.39±0.069^{bcd}	31.90±0.000^{c}	0.11±0.000^{gh}	167.00±38.84^{b}	35.00±2.89^{hi}	14.0±2.89^{i}	72.00±8.660^{b-e}	70.00±11.547^{b}
42 *A. leocarpus*	6.28±0.038^{c-g}	28.30±0.000^{p}	0.14±0.000^{efg}	69.10±13.05^{b}	80.00±5.77^{c}	42.00±5.77^{a-d}	153.00±6.928^{a-d}	95.00±2.887^{b}
42 *E. cyclocarpum*	6.27±0.012^{c-g}	29.50±0.000^{l}	0.28±0.000^{a}	56.30±0.25^{b}	100.00±5.77^{ab}	24.50±3.18^{d-i}	186.50±101.902^{ab}	45.00±8.660^{b}
42 *G. sepium*	6.13±0.035^{gh}	23.30±0.000^{v}	0.11±0.000^{gh}	97.70±17.94^{b}	70.00±0.00^{cde}	40.50±0.29^{a-e}	175.50±31.466^{abc}	95.00±2.887^{b}
42 *L. leucocephala*	6.16±0.056^{fgh}	26.10±0.000^{t}	0.16±0.003^{ef}	58.10±5.55^{b}	50.00±5.77^{fgh}	42.00±3.46^{a-f}	78.50±19.341^{b-e}	85.00±8.660^{b}
42 *T. africana*	6.05±0.017^{h}	28.10±0.000^{q}	0.18±0.000^{de}	1983.20±1924.90^{a}	60.00±0.00^{def}	42.00±1.73^{a-d}	39.50±6.640^{de}	85.00±8.660^{b}
42 **Control**	6.46±0.035^{abc}	31.70±0.000^{d}	0.12±0.001^{fg}	361.60±3.30^{b}	45.00±8.66^{f-i}	37.50±1.44^{a-h}	1134.50±58.024^{a-e}	380.00±184.752^{a}
56 *A. leocarpus*	6.35±0.026^{b-f}	30.70±0.000^{g}	0.16±0.001^{ef}	87.80±3.77^{b}	45.00±2.89^{f-i}	21.00±10.39^{hi}	143.00±52.539^{a-e}	75.00±2.887^{b}
56 *E. cyclocarpum*	6.45±0.066^{abc}	27.50±0.000^{s}	0.14±0.000^{efg}	47.30±1.99^{b}	85.00±2.89^{bc}	16.00±4.62^{i}	80.50±6.640^{b-e}	60.00±0.000^{b}
56 *G. sepium*	6.40±0.012^{bcd}	25.30±0.000^{u}	0.11±0.000^{gh}	131.10±4.00^{b}	70.00±0.00^{cde}	44.50±2.02^{abc}	99.00±12.702^{a-e}	90.00±0.000^{b}
56 *L. leucocephala*	6.23±0.012^{d-h}	27.50±0.000^{s}	0.14±0.000^{efg}	68.50±6.64^{b}	60.00±5.77^{def}	46.00±11.37^{ab}	112.50±45.889^{a-e}	90.00±11.547^{b}
56 *T. africana*	6.35±0.081^{b-f}	28.90±0.000^{n}	0.14±0.000^{efg}	68.70±6.95^{b}	45.00±2.89^{f-i}	28.00±1.15^{c-i}	192.00±63.509^{ab}	65.00±2.887^{b}
56 Control	6.43±0.032^{bcd}	31.30±0.000^{e}	0.16±0.005^{ef}	157.20±5.83^{b}	40.00±0.00^{ghi}	22.50±3.75^{f-i}	94.00±42.724^{a-e}	85.00±2.887^{b}
84 *A. leocarpus*	6.35±0.141^{b-f}	28.70±0.000^{o}	0.14±0.000^{efg}	86.00±17.74^{b}	30.00±0.00^{i}	50.50±4.91^{a}	11.00±1.732^{e}	65.00±2.887^{b}
84 *E. cyclocarpum*	6.45±0.066^{abc}	30.30±0.000^{i}	0.13±0.001^{fg}	40.50±0.49^{b}	70.00±11.55^{cde}	23.50±4.91^{e-i}	183.50±0.289^{ab}	65.00±8.660^{b}
84 *G. sepium*	6.39±0.058^{bcd}	28.30±0.000^{p}	0.11±0.000^{gh}	43.70±1.85^{b}	60.00±11.55^{def}	22.00±1.15^{ghi}	70.00±9.815^{b-e}	70.00±5.774^{b}
84 *L. leucocephala*	6.24±0.046^{bcd}	39.10±0.000^{a}	0.21±0.000^{cd}	194.20±49.18^{b}	35.00±2.89^{hi}	38.30±11.46^{a-h}	65.50±29.734^{b-e}	95.00±8.660^{b}
84 *T. africana*	6.37±0.118^{b-e}	28.90±0.000^{n}	0.18±0.000^{de}	69.9±10.85^{b}	50.00±0.00^{fgh}	29.50±1.44^{b-i}	121.00±45.611^{a-e}	70.00±5.774^{b}
84 **Control**	6.62±0.040^{a}	31.30±0.000^{e}	0.14±0.000^{efg}	85.4±10.93^{b}	30.00±5.77^{i}	28.50±1.44^{b-i}	57.50±1.443^{b-e}	55.00±2.887^{b}

Means followed by the same letter(s) within the same row and treatment are not significantly different at 5 % level of probability using DMRT.
OC: Organic Carbon; **N:** Nitrogen; **P:** Phosphorus; **K:** Potassium; **Ca:** Calcium; **Mg:** Magnesium; **Na:** Sodium.

decomposers. The increase in potassium content was a result of increased elimination of competitive weeds, better hydrothermal regime, and higher root biomass (Gupta et al. 1993; Bhat, 2004; Singh et al. 2010).

Soil exchangeable cations measured varied with days as calcium content showed its highest value on day 42. The variation was a result of the breakdown in organic material which releases soluble calcium nutrient to the soil and in turn increased the soil nutrient availability under mulch (Bhat, 2004; Singh et al. 2010; Lalitha et al. 2010). The highest magnesium content was also observed on day 42. Sodium content varied with days and was observed to be the highest on day 42. Soil exchangeable cations, according to Brown and Lemon (2008), depend on organic matter, pH and nutrient availability.

Conclusions

In conclusion, the application of leafy biomass as mulch (organic materials) serves as an alternative to NPK fertilizer, which is inorganic in nature. The rapid decomposition of *L. leucocephala* and its nitrogen fixing ability makes it an organic based material that can be used to replenish soil fertility in lowland soils.

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