Effects of over story Tree Litter Quality on Nutrient Release Pattern to the Understory Native Grass Species

Gichuki P. Mwangi, Mworia Mugambi, John Muchiri

***Abstract*— Tree litter falls is a major pathway of enhancing nutrients cycling to the understory grass vegetations. The main objective of the study was to evaluate the effects of over-story tree litter quality on nutrient release pattern to the under-story native grass species. A composite sample of freshly fallen leaves was collected. Leaf samples were homogenously mixed and put in nylon litter bags of 2mm mesh size and 25g weight. Each 7 marked points (1, 10, 20, 30, 40, 50 and 60m) had 3 samples litter bag weighing 25g. A total of 84 litter bags were collected from the adjacent pastures which include 21 litter bags from Eucalyptus, 21 litter bags from Acacia, 21 litter bags from Cypress and 21 samples litter bags from the control. They were taken to the laboratory for litter analysis and later reburied back to the points where they were collected. They were first retrieved from the points they were buried at the end of dry season and later at the end of wet season. Data was summarized using excel package and then analyzed using Statistical Package for Social Sciences (SPSS) for window version 22. All the hypotheses was tested at α=0.05. The results of the study show that tree litter quality influences resource supply to the understory native grass pastures. The findings is thought to provide valuable information to National Environmental Management Authority (NEMA), community leaders, Kenya Forestry Services (KFS), opinion leaders, extension officers, farmers and NGOs.**

***Index Terms*— Litter Quality, Decomposition Rates, Nutrients Release Pattern.**

I. INTRODUCTION

BACKGROUND OF THE STUDY

Litter is considered as one of the major limiting factor to the understory vegetation cover (Rezai, Etemadi, Nikbakht, Yousefi & Majidi, 2018). Humidity, temperature and species composition of the understory is strongly influenced by over-storey vegetation characteristics (Alizadeh & Sayedian, 2017). Ecological and systematic feature of understory grass species can better explain the structure of over-storey vegetation litter quality (Haque & Rahman, 2009). The amount of litter produced strikes the balance between litter productions and litter decomposition rates (Guo & Sims, 2002).Decomposition of litter is dependent on litter chemistry, presence of microbial community and soil fauna(Cortez et al., 2014). Litter deposits on the over-storey vegetation have been found to have inhibitory effects on understory grass cover, composition and richness. The litter quality, quantity and microbial processes play an important role in maintaining soil fertility in terms of carbon budgeting, nutrient cycling and soil organics matter formation (Wang et al., 2013). Nutrient pools are obtained through litter decomposition and released nutrients are mainly absorbed though the fine roots on the forests floor (Haque & Rahman, 2009). A critical factor that attributes to the differences in mineralization and immobilization of organic compounds is C/N ratios. A higher leaf litter C/N ratio over 30, microbes becomes N limited and therefore the process of resourcing exogenous sources inorganic nitrogen starts (FAO,2011). Litter decomposition and releasing in soil depends on the effects of litter substrate quality and physio- chemical mineral association to a particular plant (Gregoriou , Pontikis & Vemmos, 2007).The composition of plants' litter and substrate quality are the linkages that influence microbial response to decomposition (Alizadeh & Sayedian,2017).

Gichuki P. Mwangi, Department of Agriculture and Natural Resources, Faculty of Science and technology of the Kenya Methodist University
Mworia Mugambi, Department of Agriculture and Natural Resources, Faculty of Science and technology of the Kenya Methodist University
John Muchiri, Department of Agriculture and Natural Resources, Faculty of Science and technology of the Kenya Methodist University

II. MATERIALS AND METHODS

(A) Location of the Study

The study was conducted in Semi-arid South Marmanet forest in an area within 3km square. The area is approximately 300 kilometers from Nairobi. The area lies within the longitudes of $36^0$40" East to $37^0$20" East. The West and East point of the study area, just touches the equator (0^0) and extends to 0^0 15 South and North. The area had gently sloping hills with well drained clay-loam soils. The adjacent native grass areas consist of section of either Eucalyptus plantations (*E. Globules)*, Cypress or Acacia tree stands.

(B) Climatology

The study area had daily temperatures ranges between 14 to 25^0C; Altitude - 2200 to 2400 m above sea level. On average, the warmest month(s) are January and February. Most rainfall (rainy season) is received between the month of April and June. The average rainfall ranges between 500 mm - 700 mm (Kenya Forestry Service, 2009).

(C) Marking of Plots Distance

Experimental marked points which start from the tree stand were made. A distance of 1, 10, 20,30,40,50 and 60m from each tree stand was marked. Each of the above marked points; a radial circle sampling method was used to get the litter and soil samples. This involves a radius of 1m all around the marked points in the direction of 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°. This sampling method was adopted to ensure a collective litter and soil samples were taken from each marked point in different directions.

(D) Obtaining Ground Grass Biomass from tree stand

To obtain the above ground grass biomass sample from the tree stands. A distance of 1, 10, 20,30,40,50 and 60m from each tree stand was marked. Each of the above marked points; a radial circle sampling method was used to get collective litter samples. This involved a radius of 1m all around the marked points in the direction of 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°. A quadrat 0.25m² was laid on each direction and litter samples were collected inside the quadrat. This was aimed at getting above ground biomass of vegetation away from the tree stand. Each marked points (1, 10, 20, 30, 40, 50 and 60m); a serrated knife was used to harvest the grasses that grow near the surface of the soil. One grass biomass sample representing 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° was obtained by dividing the number of quadrat made by 8 different directions. The harvested grass samples were put carefully in labeled bag that included quadrat number and the area collected (E) Obtaining above Ground Grass Biomass from control

To obtain above soil sample from control (Open native grass without trees nearby), an experimental plot (10x70m) was identified. A distance of 1, 10, 20,30,40,50 and 60m from first marked point in an open native grass area was made. Each of the above marked points; a radial circle sampling method was used to get collective litter samples. This involves a radius of 1m all around the marked points in the direction of 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°. A quadrat 0.25m² was laid on each direction and litter samples were collected inside the quadrat. This represented litter samples for the control experiment. All the grass that was within the framework of quadrant was harvested. A serrated knife was used to harvest the grasses that grow near the surface of the soil. The harvested grass samples were put carefully in labeled bag that includes quadrat number and the area collected.

(F) Quantifying Species Composition

A taxonomist from Kenya Forest Service (KFS) South Marmanet Forest was contacted to determine grass species composition. The names of individual grass species within the quadrat was evaluated by identifying their taxonomical names (both scientific and common names). The frequency of the grass species was also evaluated by counting the number of individual grass species as they occur within the quadrat. Their frequency varied from 0% to 100%.

(G) Determining percentage of Species Cover

After the taxonomist from the Forest Service (KFS) had established the individual grass species, the numbers of individual grass species within the quadrat were evaluated by counting the number of individual grass species and dividing them by area of the quadrat.

$$\frac{\text{Number of species in the quadrat X 100}}{\text{Area of quadrat in m}^2}$$

(H)Determining Percentage of Species Richness

After identification of individual species, the level of disturbance was evaluated by comparing relative abundance of species between along the adjacent pastures and the open grass pasture.

$$\frac{\text{Number of species in the quadrat X 100}}{\text{Number of species in the quadrat in open grass land(Undisturbed vegetation)}}$$

(I) Determining Bulk Density

A quadrat 0.25m² was used to mark the area where sample litter was corrected. Litter was excavated carefully using a trowel around the quadrat area. Care was taken to avoid mixing litter and the duff layer. The mass of the litter was weight using sensitive mass balance instrument. Average litter depth was marked. The volume of litter collected was calculated by multiplying area (0.25m²) X depth of the litter. The bulk density was calculated by dividing dry mass of the litter by volume of litter collected

$$\text{Litter Bulk Desity} = \frac{\text{Dry mass of the litter}}{\text{Volume of the litter collected}}$$

(J) Determining Duff density

A quadrat 0.25m² was used to mark the area where sample duff litter was to be collected. Leaf Litter was excavated carefully using a trowel around the quadrat area until where the duff reaches. Care was taken to avoid mixing litter and the duff layer. Duff layer was the excavated until where mineral soil reaches. Duff litter was collected and put in plastic bag for analysis. Average duff depth was marked. The mass of litter was established by weighing it using a sensitive mass balances instrument. The volume of litter collected was calculated by multiplying area (0.25m²) X depth of the litter. The bulk density was calculated by dividing dry mass of the litter by volume of litter collected

$$\text{Litter Duff Desity} = \frac{\text{Dry mass of the duff litter}}{\text{Volume of the litter collected}}$$

(K) Obtaining Grass litter Samples (Litter bag Experiment)

A composite sample of freshly fallen leaves was collected at the start of experiment. The collected leaf litter was mixed thoroughly to get composite litter sample. Leaf samples was homogenously mixed and put in nylon litter bag of 2mm mesh size and 25g mass. Each 7 marked point (1, 10, 20, 30, 40, 50 and 60m) had 3 samples litter bag weighing 25g. A total of 84 litter bags were collected from the adjacent pastures which include 21 litter bags from Eucalyptus, 21 litter bags from Acacia, 21 litter bags from Cypress and 21 samples litter bags from the control. They were labeled according to the distances from tree stand collected. During the initial analysis of the litter, a total of 28 litter bags from seven collected points were taken to the laboratory for litter analysis. The other 56 out of 84 not selected was taken back to the point where they were collected, reburied at a depth of 15cm at a distance of 1,10,20,30,40,50 and 60m away from tree stand. At the end of dry season, a total of 28 litter bags were retrieved back from the point they will be reburied. At the end of wet season, the remaining 28 litter bags were retrieved back from point they were reburied. They were taken to the laboratory for physical and biogeochemical analysis. All the laboratory litter bags collected were put in plastic bags to prevent moisture loss and stored in temperature of 5°C before taken for analysis.

III. TREATMENTS

(a) Seasonal Treatments

The experiment had two season treatments. (i) Dry Season (DS) (ii) Wet seasons (WS). Different vegetation types was subjected to the two seasonal types and the samples will be collected in each season

Table 3.1 Seasons Treatments

Dry season	DS
Wet season	WS

(b) Vegetation Treatments

The experiment consisted of four different vegetation types Eucalyptus Vegetation type

Cypress Vegetation type
Native Acacia vegetation types
Native grass Vegetation type(Control)

Table 3.2 Vegetation Treatments Types

Stand Type	
Eucalyptus tree stand	EP
Cypress tree stand	CY
Native Acacia	AC
Native grass (Control)	NG

(c) Distance Treatments
There was seven marked point distance from each tree stand measured in metres as follow: 1, 10, 20, 30, 40, 50 and 60m.

Table 3.3 Distance Treatments

Marked point	Distance(m)
D1	1
D2	10
D3	20
D4	30
D5	40
D6	50
D7	60

IV. DATA COLLECTION

(a) Measurement of the Soil Porosity
To determine soil porosity, soils from different adjacent pastures, sample soil was put in a beaker at the same level. The water was then poured into each of the beaker until it reaches the top .The porosity was determined by dividing the volume of water that was able to be poured into the soil inside the beaker by total volume of the soil in the beaker. The result was the expressed as percentage

(b) Quantifying Soil N in the Sample
200g of soil was measured. It was sieved with 2mm sieve and stored with air tight jars at 20°C in the dark for 4 weeks. 70g of soil from the 200g soil was measured and shaken for one hour and filtered with a filter paper. Total soil N was measure by digestion with H_2SO_4, salicylic acid, H_2O_2 and selenium as described by Novozamsky et al. (1984) (Which has been 'reference' methods compared to other methods). The increase in mineral N between week 1 and week 6 was used to determine N mineralisation rates.
(c) Quantifying Microbial biomass Nitrogen (MBN)
After obtaining total soil N in the sample by digesting it with H_2SO_4, salicylic acid, H_2O_2 and selenium.Fumigation was done using chloroform to kill all the microbes in the sample. Samples were oven dried at105 °C and weighed. The differences in mass before fumigation and after fumigation showed the Microbial Biomass Nitrogen (MBN) from total N in the sample
(d) Quantifying Soil Carbon in the sample
70g of Soil samples was oven-dried at 105 °C. Organic matter content was measured by loss-on-ignition (Ball, 1964). Samples were digested with H_2SO_4, salicylic acid, H_2O_2 and selenium as described by Novozamsky et al. (1984) (Which has been 'reference' methods compared to other methods).Total soil Carbon was then obtained.
(e) Quantifying Microbial biomass Carbon (MBC)
After obtaining total soil C in the sample by loss-on-ignition and then digesting them with H_2SO_4, salicylic acid, H_2O_2 and selenium. Fumigation was done using chloroform to kill all the microbes in the total soil C in the sample. Samples were later oven dried at105 °C and then weighed. The differences in mass before fumigation and after fumigation showed the Microbial Biomass Carbon (MBC) from total C in the sample
(f) Measurement of Total Soil Phosphorus (P)
30cm³ of soil extracts was pipette into 50 ml volumetric flasks with approximately 15 ml deionized water. Samples with high humic materials were precipitated before undergoing colorimetry. Three cm³ of extract was pipette into a centrifuge rube with 0.5 ml 0.9M sulfuric acid (H_2SO_4), centrifuged for five minutes at 8000 x g. The sample was then neutralized using phenolphthalein indicator (1%), 5M sodium hydroxide (NaOH) and 2M H_2SO_4. Following this, 4 ml of colour developing solution was added and the solution was made to up 50 ml with deionized water. After 1 hour (to allow for full colour development) the colour was assessed by absorbance at 880 nm with a UV spectrophotometer. Phosphorus content was then calculated using a standard curve ranging from 0-0.5 µg P/mL (Schenck & Péréz, 1988).

(g) Quantifying Microbial Biomass Phosphorus (MBP)

After establishing total soil Phosphorus (P) in the samples, 5g of the samples were fumigated using chloroform. This was aimed at killing all the microbes in the total soil P in the sample. Samples were later oven dried at 105 °C and then weighed. The differences in mass before fumigation and after fumigation showed the Microbial Biomass Phosphorus (MBP) from total P in the sample
(h) Measurement of Soil pH and Soil Moisture
An appropriate amount of soil (10-20 g) was dried at 105°C for 24 hours (Blakemore et al., 1987). Soil moisture was calculated as the weight lost per gram after oven drying for 105°C. A 10 g (dry weight equivalent) sample of moist soil was dispersed in 20 ml of deionized water and the pH was measured after 30 minutes (Blakemore et al., 1987).
(i) Measurement of Decomposition of Leaf Litter and the Soil
After the initial litter and soil sample analysis, the leaf litter and soil samples was buried and retrieved during dry and wet season. They were brought back to laboratory for analysis. Samples were oven dried at 80°C. The loss in dry mass of leaf and soil samples were calculated from the initial converted oven-dry mass and remaining mass. The rates of decomposition were calculated from the percentage of mass loss divided by respective days of sample collection.

V. RESULTS AND DISCUSSIONS

(a) Stands Litter Quality and their Decomposition Rates
Average bulk depth, duff depth and total litter depth was measured in centimeters. The main aim was to compare different stand litter depth and the rate at which litter decomposes on the floor of the tree stand. The results are as shown in the table below

Table 2 Average litter bulk, duff and total litter depth

	Bulk depth(cm)	Duff depth(cm)	Total litter depth (cm)
Eucalyptus	6.8 cm	6.3cm	13.1cm
Acacia	2.4cm	2.2cm	4.6cm
Cypress	3.1cm	2.9cm	6cm
Control	1.9cm	1.3cm	3.2cm

From the table 2 Eucalyptus had the highest bulk depth (6.8cm) among the three exotic stands and the control. The same tree stand had also the highest duff density and the total litter depth was 13.1cm.Cypress tree stand had the second highest bulk depth of 3.1cm and duff density of 2.9cm.The total litter depth was 6cm.Acacia had the least bulk depth among the three stand but higher than the control. Bulk depth was 2.4cm while the duff density was 2.2cm.The total litter depth was 4.6cm.The results indicate that Eucalyptus litter does not decompose easily and therefore higher total litter depth. The rate of litter conversion to soil is slow resulting to higher bulk and duff depth.

(b) Comparison of Stand Litter Differences in Chemical Composition

Different common chemical analysis was carried out to determine differences in stand chemical compounds. The results is as shown in table 3

Table 3 Comparison of Stand litter differences in chemical composition

Source of Variation	Lignin	Lignin : N ratio	Lignin Pratio	Tannins	Polyphenols	Cellulose
Eucalyptus	37%	1:321	1:645	8.6%	4.7%	23%
Acacia	24%	1:127	1:211	2.1%	1.3%	31%
Cypress	29%	1:222	1:532	7.4%	1.9%	25%

From the table above, Eucalyptus had the highest (37%) lignin percentages across all the three stands. The ratio of lignin to Nitrogen was 1:321 while that of lignin to Phosphorus was 1.645.Under the chemical compound the percentages of litter chemical tannins, polyphenol and cellulose was 86%, 4.7% and 23% respectively. Cypress tree stand was the second with lignin ratio of 29% and lignin N ratio of 1:222 while lignin P ratio was 1:532.The percentages of tannins, polyphenols and cellulose was higher than Acacia with 7.4%,1.9% and 25% respectively. Acacia hapd the least in lignin percentages (24%) and had closer lignin N and P ratio of 1:121 and 1:211 respectively. It also had a lower tannins, polyphenols and cellulose of 2.1%, 1.3% and 31% respectively. The study results shows that Eucalyptus litter had higher percentages of chemical compounds than the other two stands. These compounds may serve as a source of variations in decomposition level and release of nutrients

(c) Effects of Stand Litter Quality on Microbial Biomass, Species Compositions, Richness and Cover

Table 4 below shows relationship between microbial biomass effect on species composition, richness and cover. In adjacent pastures next to Eucalyptus, species compositions were affected by litter quality that yields Microbial Biomas Nitrogen (MBN). Litter quality in Eucalyptus adjacent stand failed to release litter Nitrogen hence denying the growing grass species enough Nitrogen. This created relative significant difference in species composition as some of the grass species failed to generate. Changes in season did not significantly affect species composition at ($P<0.05$) since mineralization of Nitrogen was still being affected by leaf composition and quality. The microbial biomass phosphorous did not significantly affect the adjacent pasture species composition at ($P<0.05$). However microbial biomass carbon (MBC) has an effect on species composition. This might have been possible because of litter carbon mineralization effect. Carbon mineralization in Eucalyptus leaf litter was slow due to its chemical composition. This delayed the release of minerals necessary for the growth of some species. Only grass species that were able to survive in such condition was able to survive. This significant affected the ration of grass species composition.

In Acacia, microbial biomass Nitrogen did not control species composition at ($P<0.05$). The species did not differ in composition. Other microbial factor such microbial biomass carbon (MBC), microbial biomass phosphorous (MBP) and MBN: C ration did not significantly affect species composition at (P<0.05). Season changes in Acacia adjacent pastures also did not affect the relative ratio of species composition.

Cypress adjacent pasture has a significant effect on species composition at (P<0.05). Failure of the leaf litter to release Nitrogen affected the species composition against control. Only grass species with perennial characteristic and unpalatable such as *cynbopogon nardus* were able to survive in relative to others. Season changes not however had significant effect on species composition at (P<0.05).

Species richness is another component of species abundance in adjacent pastures. Under the eucalyptus adjacent pasture, the amount of MBN production in the leaf litter significantly affect species richness at (P<0.05). The ability of leaf litter to yield Nitrogen, affect the number of species (richness) per unit quadrat. Other microbial Biomass such MBC, MBP and MBN:C ratio also control the species richness at (P<0.05). This was highly affected by the mineralization level of eucalyptus leaf that failed to release nutrient during grass establishment stages. Season however, did not significantly affect the species richness at (P<0.05). The decomposition level during wet seasons was still low delaying the release of the required nutrients to the adjacent soil.

Acacia tree stand had significant effects on adjacent pasture richness. The labile litter in Acacia leaf promoted the growth of species in number. This was significantly higher that the two exotic stand but slight lower than control at (P<0.05). Changes in seasons in decomposition of MBN to release litter Nitrogen had a significant effect of species richness. Higher species numbers were observed during wet season than in dry season. The release of MBC at (P<0.05) also affect the number of species since the litter in Acacia leaf was able to decompose quickly enabling the adjacent pastures to acquire required nutrient as a result of carbon mineralization (Figure 1) Other microbial biomass such MBP and MBN:C ratio were also significant at(P<0.05).The rate of decomposition to release required nutrients affected the number of species more against control.

Cypress just like in Eucalyptus, the MBC, MBN and MBN:C ration had a significant effect at (P<0.05). Litter decomposition was slow down, hence affecting the species richness. The number of species per unit 0.25m^2 quadrat was lower than that of Acacia and control. However, it was much higher than that of Eucalyptus.

Species cover was another component of species abundance. In Eucalyptus species, MBW was observed to affect the species cover at (P<0.05) (figure 4.5) MBN had a significant effect in decomposition of litter Nitrogen. This probably affected the release of nutrient hence affected the species cover in relation to bare ground cover. Season had significant effects on species cover were obtained during wet season. Other microbial biomass such as MBC, MBN:C also found to control species cover.

In Acacia adjacent pastures, MBN, MBC as well as MBN:C were also found to affect species cover at (P<0.05). Cypress just like in Eucalyptus, leaf litter also found to slow down release of Nitrogen, hence controlling microbial biomass such as MBN, MBC and MBN:C ratio at (P<0.05). Simial finding were also found by Díaz-Pinés et al.(2011), Zhang et al.(2013)and Parton etal.(2009).

Table 4 Means Treatment for Microbial Biomass Factor on Species Composition, Richness and Cover

	Species composition				**Species Richness**				**Species Cover**			
	MBN	MBC	MBP	MBN;C	MBN	MBC	MBP	MBN;C	MBN	MBC	MBP	MBN;C
Eucalyptus	134.2**	436.9**	413.2	321.7*	338.2**	356.9**	423.2**	333.2**	249.2**	326.9**	453.2**	363.2**
Seasons	231.4*	327.5	322.4	453.6	233.5	329.6	341.8	375.9	327.1	353.5**	422.7	366.7*
Acacia	45.3	42.3	43.7	36.4	39.7**	41.6**	41.8**	47.1*	46.1**	41.3**	44.1**	43.5**
Season	311.3	422.4	421.8	487.5	437.5	432.7**	433.5	422.6	437.1	462.9**	432.4**	466.1**
Cypress	39.6**	41.7**	42.8	39.3**	41.7**	42.1*	39.6**	43.2**	41.6**	46.7**	41.9**	46.3**
Season	222.1*	265.3	277.3	255.6	277.8	271.1**	282.8	277.8	263.2	253.1**	277.3	288.7
control	46.3*	43.3	51.3	42.9*	46.4*	43.9	51.1	44.8*	47.4*	46.8	54.3*	47.4*
Season	322.1*	344.5	369.1	341.7	364.1	322.6	366.7	322.7	322.7	321.8**	354.2**	354.2**

Horizontally,***means are significant (p<0.05).* means are significant at (p<0.01)

(d) Effect of Stand litter: P,N,C & NO-3 on Species Composition, Richness and Cover

Figure 5 shows responses of grass species in terms of composition, richness and cover in relation to P, N, C and NO3 of the adjacent pastures. In eucalyptus, phosphorous (P) did not significantly affect species composition. However release of Nitrogen (N) to the leaf litter had a significant effect (Table 5) above. Carbon (C) and Nitrate (NO-3) did not also affect the species composition. Season had no significant effect in phosphorous (P) but had a significant effect on Nitrogen (N) and NO-3. No significant effect was observed in Carbon (C) at(P<0.05).

In Acacia adjacent pasture, no significant effect was observed at (P<0.05) on species composition on P, N, C and NO-3. The species composition relative ratio remained the same. Cypress adjacent pastures had a significant effect on N and NO-3 release in the leaf litter and therefore affected the adjacent pasture (Table 5). The chemical composition in the litter, might have affected relative ratio of composition against control. The finding were also observed by Parton et al.(2009) that some compounds such as polyphenolic substance inhibit the activity of micro-organism. Others may render N inaccessible to majority of decomposition microorganisms where by N mineralization may occur

Under the species richness, eucalyptus adjacent pastures were affected on P, N and NO- 3 ratio at (P<0.05). Season had a significant effect as more species per 0.25m2 quadrat were found. In Acacia adjacent pastures no significant effect in term of P, N and C but significant is NO-3. Faster mineralization of Nitrogen might have encouraged more species per unit quadrat.

Cypress adjacent pastures had significant difference in terms of N and NO-3. Higher species numbers were found. However, no significant difference were found to affect species richness in term of Carbon (C) and Phosphorous (P) at (P<0.05). Changes in seasons had no significant difference (P<0.05).

Under the species cover, eucalyptus adjacent pasture had significance difference in terms of Nitrogen (N) and NO-3 release to the leaf litter at (P<0.05). Higher species covers were observed during wet season than in dry season. No significant effects in specific cover in term of Phosphorous (P) and Carbon (C) were found.

In Acacia adjacent pastures, significant effects were observe during wet season and therefore season had a significant effects species cover. However, only Nitrogen and NO-3 were observed to have changes in species cover during different seasons.

Cypress has the similar significance difference in term of Nitrogen and NO-3 just like eucalyptus significance different (P<0.025) were observed Nitrogen and NO-3 release but not in Phosphorous (P) and Carbon (C) season had significant difference as higher ground cover were observed during wet season forest. The findings were also observed by Lugo et al., (1995) that the rate of decomposition of litters depends on seasons and quality of lignin and phenolic compounds within the litter substrate.

Table 5 Effect of Stand litter: P, N, C and NO_3^- on Species Composition, Richness and Cover

Species composition					Species richness				Species cover			
	P	N	C	NO_{-3}	P	N	C	NO_3^-	P	N	C	NO_{-3}
Eucalyptus	235.1*	344.3**	211..4	324.5*	233.4*	235.5**	733.3	227.6**	349.7	443.3**	367.5	434.5**
Season	433.5*	322.5**	453.5	266.2**	344.2*	463.1**	633.2	644.3**	633.2*	533.3**	356.3	322.4**
Acacia	246.5	324.5	465.5	453.2	456.4*	364.3*	453.4	443.6	423.5	532.4*	644.3	543.4
Season	422.4	645.3**	564.3	433.6	244.5	356.4**	453.4	563.4**	432.4*	453.4**	432.4	534.4**
Cypress	432.3	433.5**	423.4	432.4*	453.3*	432.3**	542.4	643.3**	564.3	653.1**	543.3	463.5*
Season	325.5	456.3**	543.3	453.5**	543.2*	567.3**	345.3	453.6**	453.2	543.2**	564.3	453.2**
Control	342.5	344.2	453.2	456.3	543.5	544.5	432.4	533.3	543.2	636.6	643.1	432.5
Season	544.4	532.4*	533.3	433.3*	432.4*	433.5*	435.3	533.4*	459.9	478.6*	547.7	476.6*

HORIZONTALLY, **MEANS ARE SIGNIFICANT (P<0.05).* MEANS ARE

(E) EFFECT OF STAND LITTER QUALITY ON DECOMPOSITION RATE OF LITTER NITROGEN

Litter decomposition characteristics were evaluated in two seasons. The results were recorded after both dry and wet seasons. Samples were taken to the laboratory for N pools analysis for the litter. Table 6 shows the results. From the study results, Acacia adjacent pastures had the highest litter Nitrogen loss with 6.5%, to 5.5% during dry season and 12% to 10% in wet season for distances of 1-30m away from tree stand. There was no significance difference in litter nitrogen loss between distances 40 – 60m away from the tree stand against the control.

Cypress adjacent grass pastures had the second highest litter Nitrogen loss. Unlike Acacia, near distance from the tree stand recorded lower litter Nitrogen loss than the control (Mass loss of 0.28g to 0.42g with 3.4% and 4.3% during dry season and 0.25g to 4.0g with 6.9% to 11% in wet season). Seasons had significant effects on litter Nitrogen loss with the wet season recording higher N loss than the dry season. There was progressive significant increase in percentage as the distance increases away from the tree stand. The adjacent pasture next to cypress was affected by the presence of tree stand to a distance of 30m away. No significant difference was found between distances of 40-60m away against control.

Eucalyptus tree stand had the lowest Nitrogen loss in the litter. The amount of Nitrogen loss was lower in near distances than in far distances away from the tree stand. The study also recorded significant increase in the amount of Nitrogen loss in both seasons. Wet season had a higher N loss recorded than dry season. Eucalyptus tree was found to affect the Nitrogen decomposition level to a distance of 50m away from the tree stand. This was 10m significantly higher than the other stands. There was no significant record of mass loss in eucalyptus after a distance of 50m away from tree stand against control. The observation was in line with those of Cortez et al. (2014) that low decomposition of floor litter under eucalyptus and its recalcitrant litter quality explains the low level of P,N and K

Table 6 Effect of Stand Litter quality on Decomposition rate of litter Nitrogen

Treatments		Leaf Litter Characteristics				
Tree Species	Distance From the Tree m	**Initial** Leaf Litter N g/25g	End of **(Dry Season)**	Mass Loss of N%	End of **(Wet Season)**	Mass Loss of N%
Eucalyptus	1m.	0.28g	0.27g	3.3%	0.26g	7.1%
	10m	0.27g	0.24g	3.5%	0.25g	7.4%
	20m	0.26g	0.25g	3.8%	0.24g	7.6%
	30m	0.25g	0.23g	3.9%	0.23g	8.0%
	40m	0.44g	0.41g	4.1%	0.39g	11%
	50m	0.46g	0.42g	4.3%	0.38g	11%
	60m	0.46g	0.42g	4.3%	0.38g	11%
Acacia	1m.	0.49g	0.45g	6.5%	0.43g	12%
	10m	0.48g	0.44g	6.2%	0.42g	12%
	20m	0.46g	0.43g	6.0%	0.40g	11%
	30m	0.46g	0.42g	5.5%	0.40g	11%
	40m	0.45g	0.42g	4.3%	0.39g	10%
	50m	0.45g	0.42g	4.3%	0.39g	10%
	60m	0.45g	0.45g	4.3%	0.38g	10%
Cypress	1m.	0.29g	0.28g	3.4%	0.25g	6.9%
	10m	0.25g	0.24g	4.0%	0.23g	8.0%
	20m	0.24g	0.23g	4.1%	0.22g	8.3%
	30m	0.23g	0.23g	4.3%	0.22g	8.6%
	40m	0.46g	0.44g	4.3%	0.40g	11%
	50m	0.46g	0.42g	4.3%	0.40g	11%
	60m	0.46g	0.42g	4.3%	0.40g	11%
Control (Average)		0.461g	0.423g	4.3%	0.381g	11%

Table 7 Multiple regression treatments results for Litter Nitrogen Mass loss

Treatments	Parameter	Correlation	Sig
Eucalyptus -Cypress	Species	0.692	0.014
	Distance	0.451	0.036
	Seasons	0.643	0.045
Eucalyptus -Acacia	Species	0.211	0.001
	Distance	-0.432	0.021
	Seasons	-0.321	0.034
Cypress-Acacia	Species	0.544	0.022
	Distance	-0.346	0.039
	Seasons	-0.333	0.042

Table 7 shows multiple regression treatments results for litter Nitrogen mass loss. A positive correlation of litter Nitrogen mass loss of the Eucalypts and Cypress adjacent pastures in their species, distances and seasons with r^2=0.692, r^2= 0.451 and r^2=0.643 respectively. However a negative correlation was found between litter Nitrogen mass loss of eucalyptus and Acacia in their relation to their distance r^2=-0.432 and seasons r^2= -0.321.Also another negative correlation was found between cypress and Acacia of r^2=--0.346, in their distances and r^2= -0.333 in their differences in seasons. This could have been as results of difference in their litter Nitrogen mass loss away from tree stand. Acacia adjacent pastures decreased their litter Nitrogen mass loss as the distance increases whereas cypress and eucalyptus adjacent pastures increased their litter Nitrogen mass loss with increase of the distance and seasons. Lower decomposition rate in Eucalyptus resulting to less Nitrogen mass loss in close distances could be as a result of leaf characteristics and chemistry. The observation was in the line with those of Berg & Laskowski (2006) that some exotic trees, have leaf chemistry that affects the rate of decomposition of structural Nitrogen. Differences in the decomposition of the two exotic stands and the native (Acacia) tree could also have contributed by leaf chemistry that slow down decomposition to release Nitrogen. The observation agreed with the work of Gregoriou , Pontikis & Vemmos (2007) that short term mineralization and releasing of soil nutrients through decomposition depends on the effects of litter quantity and physio- chemical mineral association to a particular plant. Season had significance effects across all adjacent tree stands. Higher decomposition rate was observed in native than exotic adjacent stands

(f) Effect of Stand Litter Quality on Decomposition of Litter Phosphorus

From the table 8 below, Acacia had the highest loss of litter phosphorus through decomposition. 1m away recorded 34% mass loss of 0.11g from the initial recorded amount 0.32g of litter Phosphorus. Increase in moisture content had a significant effect on phosphorus mass loss .A distance of 1m recorded 51% litter phosphorus mass loss. There was progressive decline in litter decomposition percentage from the initial recorded amount ranging from 34-26% in dry season and 51% to 34% in wet season from 1m-60m away from the tree stand. The decomposition level was only significant at a distance of 30m away. Any further increase in distance did not affect the adjacent pastures against control.

Adjacent grass pastures next to cypress had the second highest recorded mass loss. The recorded amount of decomposition was inversely proportion to that of Acacia adjacent pastures. Closer distances recorded the lowest litter phosphorus loss whereas in Acacia the highest loss was a distance between 1-10m away. Just like Acacia, seasons had significant effect on the amount of nitrogen loss through decomposition. The amount increased from 6.55 to 18% during the wet season. There was linear progress increase in amount of litter nitrogen loss as the distance increase from 1m-60m away from the tree stand. The effects of the tree on the adjacent grass pastures were only effective between 1-30m away from the tree stand. Further increase 40-60m did not affect the adjacent grass pastures against control. Eucalyptus had the lowest mineral phosphorus loss across the entire stand and the control. The effect of the tree was highest in distance of 1-10m away, with lowest record of 7.6% in dry season and 16% in wet season. Effect of season was significant with difference in percentage loss increasing from dry to wet season. Just like cypress tree stand, there was linear increase in the amount of P pools as the distance increase from 1-60m away. The study noted that the effect of eucalyptus tree stands was significant up to a distance of 50m. Further increase in distance did not have significance effect in the percentage loss against control. This has also been demonstrated by the work of Berg & Laskowski (2006) that various stages of decomposition can be affected by season variations in temperature and moisture content which is likely to influence various biological processes by altering soil environment.

Table 8 Effect of Stand Litter quality on Decomposition of Litter Phosphorus

Treatments		Leaf Litter Characteristics				
Tree Species	**Distance From the Tree**	**Initial** Leaf Litter P g/25g	End of **Dry Season**	Mass Loss of P %	End of **(Wet Season)**	Mass Loss of P %
Eucalyptus	1m.	0.13g	0.12g	7.6%	0.11g	16%
	10m	0.14g	0.13g	11%	0.12g	17%
	20m	0.14g	0.12g	14%	0.11g	21%
	30m	0.17g	0.13g	23%	0.12g	29%
	40m	0.19g	0.14g	26%	0.13g	31%
	50m	0.23g	0.17g	26%	0.16g	34%
	60m	0.23g	0.16g	26%	0.16g	34%
Acacia	1m.	0.32g	0.21g	34%	0.13g	51%
	10m	0.29g	0.23g	31%	0.13g	48%
	20m	0.27g	0.19g	29%	0.15g	44%
	30m	0.25g	0.18g	28%	0.16g	34%
	40m	0.23g	0.18g	26%	0.16g	34%
	50m	0.23g	0.18g	26%	0.26g	34%
	60m	0.23g	0.18g	26%	0.26g	30%
Cypress	1m.	0.16g	0.14g	6.5%	0.14g	18%
	10m	0.16g	0.14g	6.5%	0.14g	18%
	20m	0.19g	0.17g	10%	0.15g	21%
	30m	0.20g	0.19g	10%	0.16g	20%
	40m	0.23g	0.17g	26%	0.16g	34%
	50m	0.23g	0.17g	26%	0.16g	34%
	60m	0.23g	0.17g	26%	0.16g	34%
Control		0.23g	0.17g	26%	0.16g	34%

Table 9 Multiple regression treatments results for Litter P Mass loss

Treatments	**Parameters**	**Correlation**	**P value**
Eucalyptus -Cypress	Species	0.276	0.061
	Distance	0.544	0.013
	Seasons	0.653	0.014
Eucalyptus -Acacia	Species	-0.655	0.024
	Distance	-0.598	0.042
	Seasons	-0.488	0.041
Cypress-Acacia	Species	-0.632	0.05
	Distance	-0.411	0.027
	Seasons	-0.466	0.036

The results indicates that distances and seasons has significance effect on litter P in Eucalyptus and Cypress adjacent pastures with r²=0.544, r²= 0.653 respectively but not in their species. However a negative correlation was found between P mass loss of eucalyptus and Acacia to all their treatment in species, distance and seasons with r²= - 0.655, r²= -0.598 r²= -0.488 respective. There was also negative correlation between cypress and Acacia with all their treatment in species, distance and season of r²= -0.632 r²= -0.411, and - r²= 0.466. The results indicate that the mode of Phosphorus mass loss in the native Acacia tree is different from that of the two exotic stands in relation to their species, distance and seasons. In related study by (Gregoriou et al. (2007) plant species and litter substrate quality are the linkages that influences microbial response to Phosphorus mineralization and immobilization. Acacia leaf litter enabled higher P mineralization rate at closer distance than the two exotic stands due to litter quality which was easy to decompose. In a similar decomposition of litter in the forest by Chawla (2008) demonstrated that the effects of litter quality and he associated plant exudates have an advance effects on soil stabilization and mineralization process of phosphorus. The findings of this experiment are also in the line with those of Isaac & Nair (2005) who observed that charges in litter quality and quantity in the exotic tree species is a likely mechanism that causes greater P immobilization and reducing P availability. Moisture availability across all stands enabled faster decomposition rate than in dry season. This was demonstrated by higher P mineralization rate and P mass loss with increase of moisture content. Similar litter decomposition was observed by D'Antonio et al.(1992) in Arctic and Antarctic permafrost soils that microbial community structure are strongly influenced by variation of soil environment and plant litter substrate quality. Distance was also another important factor that affected decomposition and mass loss of litter Phosphorus. Closer distance from the tree stand in exotic trees reduces P mass loss and enhances higher P mass loss in native (Acacia) adjacent stand. In related study by Gaertner et al. (2011) in exotic tree next to crop land found that exotic trees adjacent to crops affect microbial decomposition and are associated with high scarcity of mineral P content. Similar studies was also found by Cortez et al. (2014) that exotic trees adjacent grass vegetation decrease environmental stability by interfering with resource supply and creation of microbial ecosystem disturbance.

(g) Influence of Stand Litter quality on Decomposition (Mass Loss) of Organic Carbon

Litter carbon decomposition characteristics were evaluated in two seasons. The results were recorded after both dry and wet seasons. Figure 1 and 2 shows the results

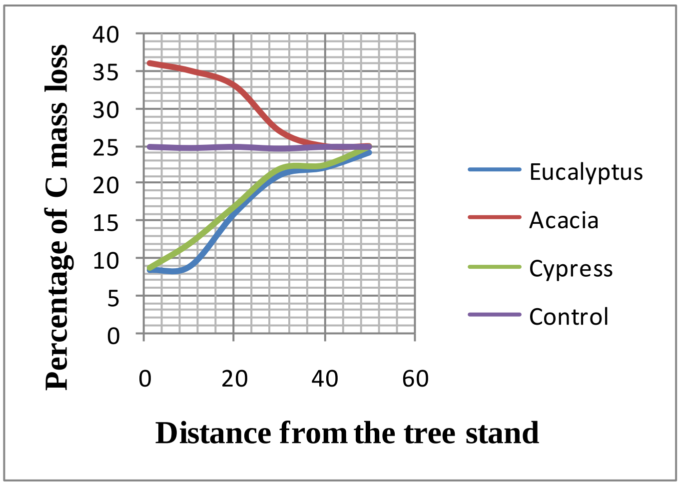


Figure 1 Influence of Litter quality on C. Decomposition (Mass Loss) of Organic Carbon (Dry season

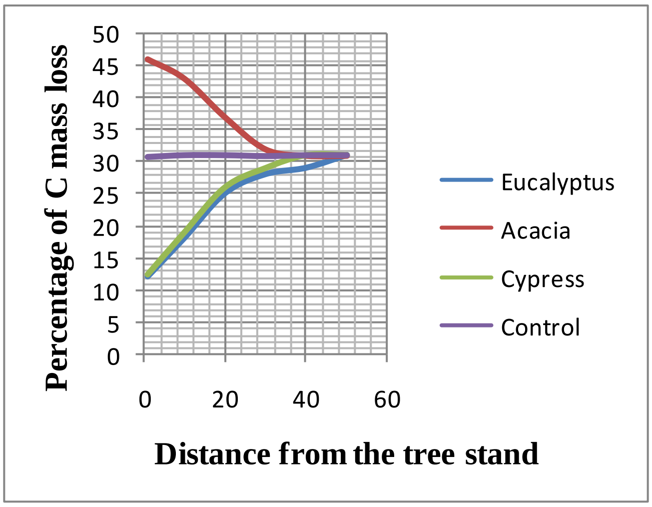


Figure 2 Influence of Litter quality on C Decomposition (Mass Loss) of Organic Carbon (Wet season)

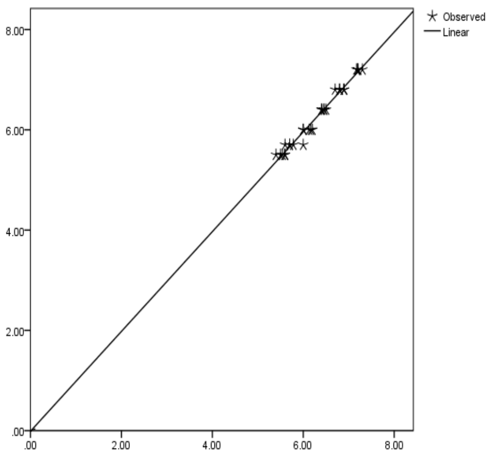
From the figure 1&2 above, the amount of carbon loss percentage across all stands increase with increase in moisture. Acacia tree had the highest organic Carbon mass loss through decomposition. A distance of 1m recorded 36% during dry period and 46% loss during the wet season. The amount recorded in percentage in distance of 1-30m was higher than all the stands and the control.

The decomposition level was in downward trend as distance increases from the tree stand. Acacia tree leaf litter provided higher decomposition level in closer distances due to its litter quality with low C:N ratio that provided fast decomposition rate. A previous study by Wang et al. (2010) found that the rate of decomposition litters depends on their quality and absent of tough lignin and phenolic compounds with high C/N ratio which lowers decomposition rate. The effect of decomposition level from initial to the end of wet season was only effective from a distance of 30m away. Further increase in distance did not affect the adjacent pastures against the control.

Cypress according to the figure 1&2 above recorded the second highest amount of carbon mass loss. The amount of carbon mass loss in litter was much less than in Acacia and in the control but higher than that of Eucalyptus adjacent pastures. There was progressive significant increase in percentage as the distance increases away from the tree stand. Just like Acacia, the effect of tree to the adjacent pastures was only effective to a distance of 30m (12.5% - 31% from 1 – 30m away). Further increase in distance did not affect the adjacent pasture against the control.

Eucalyptus had the lowest Carbon pools mass loss across the entire stands and the control. The percentage loss ranged from 8.3%-24% from a distance of 1m-60m away. The effect of the tree was effective up to a distance of 50m away from tree stand. As the distance increased the amount of carbon mass loss increased due to presence of mixed litter. The observation agreed with the work of Cortez et al.(2014) that recalcitrant litter quality explains the low level of carbon mineralization in floor litter under eucalyptus species plantation soils adjacent to crops. Unlike Acacia and cypress, season had significant effect on decomposition level of litter Carbon pools ranging from 12%-13% in wet season. The amount in both seasons increase progressively as the distance increase. In a related study by Díaz-Pinés et al.(2011) in Boreal forest rapid. Mineralization of soil organic matter is primarily trigged by moisture availability and temperature which increase the rate of microbial activities

Linear Regression Model Analysis of Litter quality and the below ground Resource



Decomposition rates	**MBN**	**MBC**	MBP	Leaf chemistry
r^2=0.74	r^2=0.71	r^2=0.66	r^2=0.57	r^2=0.66

Figure 3 Shows Regression Model of Litter quality (dependent variable) and Decomposition rates, MBN, MBC, MBP and leaf chemistry (Independent variables)

From the regression analysis (figure 3) litter quality (y=4.35x+3), was plotted against below ground resources influence (Decomposition rates, MBN, MBC, MBP and leaf chemistry) Decomposition rates had strong positive correlation of r^2=0.74 ($p<0.05$).This suggests that litter quality strongly influence below ground resources due to delay in decomposition of litter. The litter quality in relation to changes in microbial biomass Nitrogen also showed strong correlation r^2=0.71 ($p<0.05$). This mean that nutrients cycling in the soil depend on leaf chemistry (litter quality) which determines immobilization and mineralization processes. Litter quality also had significance positive relationship with microbial biomass carbon (MBC) r^2=0.66 ($p<0.05$). This indicates that microbial biomass carbon acts as transfer agent of decomposition of organic matter in the soil. Another significant relationship was also observed with microbial biomass phosphorus (MBP) r^2=0.57 ($p<0.05$).Leaf chemistry had r^2=0.66 ($p<0.05$). This shows that Litter quality had strong relationship with below ground resource which influences the above ground understory characteristics. The study results shows that litter quality is a major determinant of below ground resources which influences the above ground understory grass characteristics. Based on results finding and previously related literature the null hypothesis which stipulates that there is no significant difference between the litter quality and below ground resource influence is rejected

VI. CONCLUSIONS

Tree's Litter Quality and Decomposition Rates

- Thetypeoflitterhassignificanteffectsonthetypeoforganicmatterformed.

Eucalyptus leaf litter poses decomposition challenges to the micro-organism involved in decomposition.

- There is closer relationship on leaf litter of Cyprus and Eucalyptus in ability to decompose. Comparison of Nitrogen mass loss in Acacia and other exotic leaf litter, Acacia leaf liter is easier to decompose due to less chemical exudes that allow biogeochemical process involved in decomposition.
- The quality of litter also affects the carbon cycle as well as its cycling. Acacia tree stand recycle it carbon constituents more easily than that of eucalyptus and Cyprus. This is due to substrate quality that is easier to decompose to release mineral carbon.
- Different leaf litter significantly affects the N pools decomposition mainly because of leaf toughness especially in Eucalyptus. The leaf litter of Eucalyptus affects the adjacent pastures by slowing down the decomposition rate more than those of Acacia adjacent pastures.The rate of decomposition across all the adjacent stands is affected by seasons.

Climatical condition such as temperature, rainfall and micro-organism has significant effects on nutrient cycling in the adjacent grass pastures. The reason may be that climate and litter diversity affects the soil community activity during decomposition process.

- Association of mycorrhizal is affected by the plant litter quality. They also differ according to the type of litter in the adjacent pastures. Higher AM are found in Acacia than in Eucalyptus as a result of AM works better with organic matter with higher composition of bacterial community as oppose to ECM.
- Microbial biomass carbon (MBC) as well as MBN and MBP significantly dependant on the type of litter. This is evidenced by higher percentage of microbial biomass in Acacia adjacent pastures than those in the two exotic trees.

Litter Quality and Below Ground Resource Influence

- Maintainers of primary production in adjacent pastures depend on mass loss of the available nutrient pools in the litter and soil organic matters. In addition, litter material added to the adjacent pastures constitute of a major factor in determining nutrients cycling in grass floor.

- Decomposition of organic matter mainly depends on soil biota, litter chemistry and climatic condition of the soil.
- Litter substrate quality is an important factor that steer the rate of nutrients turn over in the understory vegetation and it's above ground response.
- Senescence leaves in Acacia has better substrate quality litter than the two exotic stands which yield more Nitrogen in near distances from the free stand.

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