Effects of Exotic Tree's Litter Quality on Responses of the Adjacent Native Grasses

[1]Mwangi, G.P. [2]Mugambi, M, [3]Muchiri, J

[1,2,3] Lecturer School of Medicine & Health Sciences,**Kenya Methodist University**

Correspondence: phillipmwangi8@gmail.com

Abstract

Abstract

Tree litter falls is a major pathway of enhancing nutrients cycling to the understory grass vegetations adjacent to it. The main objective of the study was to evaluate the effects of exotic tree's litter quality on the responses of the adjacent native grass. 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 23. All the hypotheses was tested at a=0.05. The results of the study show that tree litter quality influences resource supply to the adjacent 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.

Keywords: *Litter Quality, Decomposition Rates, Grass Biomass*

Check for Updates

Mwangi, G.P. Mugambi, M Muchiri, J

Accepted: 16 Sep 2021

Published: 21 October 2021

Introduction

Plants litter decomposition is a vital ecosystem process. It is the key pathway to the transfer of above ground carbon to the soil as well as nutrients cycling process (Ibrahima &Halima, 2008). Climate and leaf chemical composition are major factors in determining decomposition rate (Bohra, Kumar & Singh, 2015). Plant exudates influence the microbial function as well as their structure (Verhoef & Gunadi, 2001). Soil microbial organisms are highly influenced by amino acids, sugar, proteins and falconoid that a given species of plant excrete (Thébault et al.,2010). Microbial community structures are highly influenced by soil disturbance, allelopathic influence, local fauna and flora which impose selective pressure (Chawla, 2008). Soil microbial organisms are highly influenced by amino acids, sugar, proteins and falconoid that a given species of plant excrete (Wang et al., 2010). Litter quality alters of soil properties, microbial structure and function of soil roots which help to withstand stress and resilience to hatch environmental conditions (Mahmood et al., 2009). The composition and quality of litter substrate determine the abundance of selective mycorrhizal association

Materials and Methods

(i) 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.

(ii) 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).

iii) 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.

iv) 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 labelled bag that included quadrat number and the area collected.

v) 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 $0.25m^2$ 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.

(vi) 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%.

(vii) 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.

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

(viii)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.

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

(xi) 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 labelled 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.

1) Treatments

(i) Seasonal Treatments The experiment had three season treatments: Dry season (DS), Wet seasons (WS) , & Vegetation

Vegetation Treatment: The experiment consisted of four different vegetation types

(a)Eucalyptus Vegetation type (b) Cypress Vegetation type (c)Native Acacia vegetation types (d) Native grass Vegetation type(Control)

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.

Data collection

(i) *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 reached 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.

ii) *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.

iii) 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

(iv) *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.

(v) *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.

vi) *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).

(vii) 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.

(ix) *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).

(x) *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.

Results and Discussions

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 1 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 1 Eucalyptus had the highest bulk depth (6.8cm) among the three and the control. The same 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 indicated 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.

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 below:

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 3 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.

Effects of Stand Litter Quality on 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 5 Means Treatment for Microbial Biomass Factor on Species Composition, Richness and Cover.Horizontally,***means are significant (p<0.05).* means are significant at (p<0.01).

	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**

Table 5 Effect of Stand litter: P, N, C and NO$^-$ 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*

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 (figure 4.7.3). 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 different($P<0.05$).

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^- 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 Significant at($p<0.01$) **Effect of Stand Litter Quality on Soil Temperatures**

5 Effect of Stand Litter Quality on Soil temperatures

Table 6: Effect of Stand Litter on Soil Temperatures

Treatments		**Litter and Soil pH in Different Seasons**				
Tree Species	**Distance From the Tree**	Initial Soil Temperature	Dry Season Litter Temp	Soil Temp	**Wet Season** Litter Temp	**Soil Temp**
Eucalyptus	1m.	21°C	22°C	21°C	20°C	**19°C**
	10m	21°C	22°C	21°C	20°C	**19°C**
	20m	23°C	23°C	23°C	21°C	**21°C**
	30m	24°C	24°C	24°C	22°C	**22°C**
	40m	24°C	24°C	24°C	22°C	**22°C**
	50m	24°C	24°C	24°C	22°C	**22°C**
	60m	24°C	24°C	24°C	22°C	**22°C**
Acacia	1m.	23°C	24°C	23°C	23°C	**21°C**
	10m	23°C	24°C	23°C	23°C	**21°C**
	20m	23°C	25°C	23°C	24°C	**21°C**
	30m	24°C	25°C	24°C	24°C	**22°C**
	40m	24°C	25°C	24°C	24°C	**22°C**
	50m	24°C	25°C	24°C	24°C	**22°C**
	60m	24°C	24°C	24°C	24°C	**22°C**
Cypress	1m.	22°C	23°C	22°C	21°C	**21°C**
	10m	22°C	23°C	22°C	21°C	**21°C**
	20m	23°C	24°C	23°C	23°C	**22°C**
	30m	23°C	25°C	23°C	23°C	**22°C**
	40m	24°C	24°C	24°C	24°C	**22°C**
	50m	24°C	24°C	24°C	24°C	**22°C**
	60m	24°C	24°C	24°C	24°C	**22°C**
Control		**24°C**	**24°C**	**24°C**	**24°C**	**22°C**

From the above results Table 6, soil temperatures were significantly affected by the seasons across all stands and the control. Eucalyptus adjacent pastures recorded the lowest pH temperatures during wet season. This was much lower than the other stands (19°C-22 with a distance of 1-40m away from tree stand). A lower temperature was also recorded in litter during wet season ranging from 2122°C. However, an average temperature was recorded during dry season that was equivalent to other stands and the control. There was a progressive increase in soil and litter temperatures as the distance increases. No significance difference of both soil and litter temperature recorded after a distance of 50m in verses the control. Cypress and Acacia adjacent pastures recorded almost the same temperature range. A distance of 1-30m away from tree stand recorded between 23-24°C in dry season and between 21-24 in wet season. A linear progression of soil and litter temperature was observed as the distance increased away from tree stand. Season had a significance effect in both soil and litter temperatures. No significance soil and litter temperatures were observed after a distance of 40m in both Cypress and Acacia adjacent pasture verses the control.

Effect of Litter on Soil Moistures

Table 7: Effect of Litter on Soil Moistures

Treatments		Litter and Soil Moisture in Different Seasons				
Tree Species	**Distance From the Tree**	Initial Soil Moisture	Dry Season Litter Moisture	Soil Moisture	**Wet Season** Litter Moisture	**Soil Moisture**
Eucalyptus	1m.	17%	16%	12%	22%	**20%**
	10m	17%	16%	13%	23%	**21%**
	20m	18%	17%	13%	23%	**20%**
	30m	19%	17%	14%	24%	**20%**
	40m	20%	19%	16%	27%	**25%**
	50m	20%	19%	16%	27%	**25%**
	60m	20%	19%	16%	27%	**25%**
Acacia	1m.	21%	20%	17%	31%	**28%**
	10m	21%	20%	17%	31%	**28%**
	20m	19%	19%	17%	30%	**28%**
	30m	20%	19%	16%	29%	**27%**
	40m	20%	19%	16%	27%	**25%**
	50m	20%	19%	16%	27%	**25%**
	60m	20%	19%	16%	27%	**25%**
Cypress	1m.	17%	16%	14%	23%	**21%**
	10m	17%	16%	14%	25%	**21%**
	20m	17%	16%	14%	25%	**23%**
	30m	18%	17%	15%	26%	**23%**
	40m	19%	19%	16%	27%	**24%**
	50m	20%	19%	6%	20%	**25%**
	60m	20%	19%	6%	27%	**25%**
Control		**20%**	**19%**	**6%**	**27%**	**25%**

From the above study results, Table 7, soil moisture was significantly affected by the seasons across all stands and the control. Eucalyptus had the lowest soil moisture across all adjacent stands. A distance ranging from 1-40m recorded between 16-19% litter moisture content in dry season and 22—27% in litter in wet season. In soils the same distance recorded moisture content ranging from 12-14% in dry season and 22-25% in wet season. There was a progressive increase in moisture content as the distance increases. No significance difference of both soil and litter after a distance of 50m against the control. Adjacent pastures to cypress recorded the second lowest soil and litter moisture. A distance of 1-30m away from tree stand recorded moisture content ranging from 16-19% in litter during dry season and 23-26% in litter during wet season. In soil moisture content, the percentage moisture content was ranging from 14-16% in dry season and 21-25% in wet season.

Acacia recorded the highest soil and litter moisture across all the adjacent stands and the control. A distance of 1-30m recorded 20-19% in dry season and 31-27% in litter during wet season. In soil moisture content, the percentage moisture content was ranging from 17-19% in dry season and 28-25% in wet season. This was unlike other stand soil and litter content. Moisture decreased with increase in distance. Further increase in distance away from tree stand did not affect the moisture content verses the control.

Influence of Stand Litter on Ecto-Mycorrhizal Association

The initial and the final sample analysis of ecto-mycorrhizal (ECM) did not differ so much in seasons. Adjacent pastures next to cypress recorded higher ECM percentage than acacia and Eucalyptus. The percentage progressed positively as the distance increases away from the tree stand. Ecto-mycorrhizal (ECM) was founded to be in high in those regions with the deficiencies in nutrients. The adjacent pastures to cypress recorded higher mycorrhizal association as a compensation factor for mineral nutrient loss. As earlier reported by Fadil et al. (2006) exotic trees have higher associate to ectomycorrhizal than native species due substrate utilization and carbon assimilation efficiencies. This means that there is higher efficiency of mineralizing more carbon per unit substrate than without utilizing ecto-mycorrhizal. The effect of adjacent tree stand did not affect the adjacent pasture more than 30m away. No significance difference in percentage of ECM was found after 30m away the from tree stand. Eucalyptus recorded the second highest ECM after cypress, higher percentage 52 2.12 in dry season and 55 2.11% in wet season. The percentage was higher than acacia and the control at a distance of 1 – 50m away with percentage difference of 53 2.12 to 462.11 in dry season and 55 2.12 to 49 2.11 percent in wet season. There were no significant effects in percentages of Ecto-mycorrhizal after a distance of 50m away from the tree stand. Season was significant with higher percentage increase in of ECM.

Acacia adjacent pasture unlike in AM, the trend of ECM changed from high percentage at a closer distance away from the tree stand. The percentage recorded at a distance (1 – 30m) was lower that other stands and the control. The study indicates that number of mycorrhizal was lesser in litter that is easy to decompose and high in litter that does not decompose easily. This was also demonstrated by the work of Bajad et al.(2017) that litter quality affects roots mycorrhizal association. Microbes surrounded by rich rhizopheres, produces signals that enhances plants fitness and growth to a given environment. It was also found to be influenced by inter- plant communication in undisturbed environment. It was further observed by Mahmood et al. (2009) that litter quality alters soil properties, microbial structure and function of soil roots. This help to withstand stress and resilience to hatch environmental conditions Ngoran, et al. (2006)

Effect of Litter on Arbuscular Mycorrhizal Association

Effect of Aburscular mycorrhizal association percentage was measured in both dry and wet seasons. Acacia had the highest percentage of Aburscular mycorrhizal (AM) at a closer distance from the tree stand. The percentages range from 57 3.17% to 41 2.37% from a distance of 1 – 60m. A significant downward trend in mycorrhizal association was noted as the distance increases. Seasons had a significant effect on mycorrhizal AM association with higher AM recording higher percentage in wet season.

Cypress adjacent pasture recorded the higher mycorrhizal association than Eucalyptus. The mycorrhizal association was lower in a distance of 1 – 30m away from the tree stand with (35   2.22% to 54 ±2.66% in distance of 1 – 30m during the dry season. In high moisture condition (Wetseason) the percentageincreased from 432.21%   to 592.32% on distance of 1 – 60m away from the tree stand.

The effect of adjacent pasture on mycorrhizal was not significant after the distance of 30m away from the tree stand verses control. Adjacent pastures next to eucalyptus recorded relatively lower percentage than Cypress, but were significantly lower to that of Acacia and the control. Unlike the Acacia, Eucalyptus adjacent pastures AM percentages increases with the distance whereas in acacia it decreases with distance. The effect of mycorrhizal on the adjacent stand was only effective at a distance of 40 meters away. Season was significant in mycorrhizal association percentage with high moisture content recording higher percentage than in dry season. No significant AM association against control was recorded after a distance of 50 meters away from the tree stand. The findings on effects of season were also observed by Berg & Laskowski (2006) that various stages of decomposition may also be affected by season variations in temperature. Floor litter is likely to influence various biological processes and finally shift mycorrhizal association according to limited resources needed by plants.

Conclusion

- The type of litter has significant effects on the type of organic matter present. 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.
- 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.
- 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.

References

Alizadeh, M., Jafari, A. & Sayedian ,S. (2017). Evaluation of Aerial Biomass, Yield and Essential Oil Content of Seven Species of Tanacetum. Journal of Horticultural Research. 2017; 25(1):19–25R.

Chawla S. (2008). Response of African Marigold to Irrigation and Mulching. Journal of Ornamental Horticulture. 11(2):131–135.

Cortez C. T., Nunes L., Rodrigues B., Eisenhauer N., & Araújo F. (2014). Soil Microbial Properties in Eucalyptus Grandis Plantations of Different Ages. Journal of Soil Science and Plant Nutrition, 14(3):734–742

D'Antonio M. & Vitousek P. (1992). Biological Invasions by Exotic Grasses, the Grass/Fire Cycle, and Global Change. Annual Review of Ecology and Systematics, 23: 63–87.

Decomposition Under Eucalyptus and Coniferous Plantations in Gambo District, Southern Degraded Sites in South African Fynbos. Environmental Management, 48:57–69. FAO (2014). State of Food and Agriculture. Rome: FAO

Berg, R. & Laskowski, R. (2006). A Guide to Carbon and Nutrient Turnover, Amsterdam: Elsevier Scientific Publishing.

Gaertner, M., Richardson, D. M. & Privett J. (2011). Effects of Alien Plants on Ecosystem Structure and Functioning and Implications for Restoration: In-Sights from Three Degraded Sites in South African Fynbos. Environmental Management, 48:57–69

Gregoriou, K., Pontikis K. & Vemmos, S. (2007). Effects of Reduced Irradiance on Leaf Morphology, Photosynthetic Capacity, and Fruit Yield in Olive (Olea europaea L.). Photosynthetica. 2007;45(2):172–181.

Guo, L.O & Sims, R. (2002). "Eucalypt Litter Decomposition and Nutrient Release under a Short Rotation Forest Regime and Effluent Irrigation Treatments in New Zealand: Soil Biology and Biochemistry, Volume 34, Issue 7, July 2002, Pages 913-922

Haque, M., Hasanuzzaman, M. & Rahman, M. (2009). Effect of Light Intensity on MorphoPhysiology and Yield Of bottle Gourd (Lagenaria vulgaris). Academic Journal of Plant Sciences.2(3):158–161 II. Internal effects," Soil Biology & Biochemistry, vol. 34, no. 7, pp. 913–922, Go (Online-ogle Scholar

Kenya Forestry Service (2009). A Guide to On-Farm Eucalyptus Growing in Kenya. Kericho: Kenya Forestry Service

Mahmood,H. &Hoque, H.(2008). "Litter production and decomposition in mangrove—a review," Indian Journal of Forestry, vol. 3, pp. 227–238 (Online- Google Scholar).

Rezai,S., Etemadi, N., Nikbakht, A., Yousefi, M. & Majidi, M.(2018). Effect of Light Intensity on Leaf Morphology, Photosynthetic Capacity, and Chlorophyll Content in Sage (Salvia officinalis L.). Horticultural Science and Technology, 36(1):46–57.

Semwal, K., Maikhuri, K., Rao, K., &Saxena, K. K. (2003). "Leaf Litter Decomposition and Nutrient Release Patterns of Six Multipurpose Tree Species of Central Himalaya, India," Biomass and Bioenergy, Vol. 24, no. 1, pp. 3–11 (Online- Google Scholar).

Wang, Q, Zhong, M., &He, X. (2013). Home-Field Advantage of Litter Decomposition and Nitrogen Release in Forest Ecosystems. Biol Fert Soils 49: 427–34