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Indigenous Tree Species Diversity Under Exotic Plantations in Qimbaba Forest, North West Ethiopia

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Abstract
This study was carried out in Qimbaba forest, northwest of Ethiopia to determine woody species diversity, regeneration capacity and soil seed bank in Eucalyptus plantation forest and adjacent natural forest. A total of 40 circular sample plots of 314 m^2 were established along a transect line at every 200 m between them. Transects were laid in east–west directions at 200 m distance from each other. Soil seed bank analysis was done from soil samples collected in each of the 40 plots (160 samples) to examine the similarity between the soil seed flora and aboveground vegetation. A total of 71 woody plant species (33 in Eucalyptus Plantation) and (63 in Natural Forest) were determined with the density ranging between 404 to 635 per ha in the plantation and natural forest, respectively. The population structure showed an inverted J-shape in both forests. The basal area were 4.9 m^2/ha and 24.5 m^2/ha for plantation and the adjacent natural forest respectively. The regeneration status in the Eucalyptus plantation was 699 seedlings and 344 saplings/ha while the natural forest had 1117 seedlings and 390 saplings/ha. On the other hand, the species richness of regenerated trees in the plantation and natural forest were 21 and 38, respectively. A total of 14 plant species representing 11 families were recovered from the soil seed bank, 12 (in 10 families) species in the natural forest and 7 of them were in the eucalyptus plantation forest (5 families). Soil seed bank (SSB) was not similar in the two forests with Sorenson's similarity values of 0.208. There were 11,022 seeds/m^2 (natural forest) and 10,667 seeds/m^2 (Eucalyptus plantation forest) in the SSB.
Keywords: Florstic diversity, Eucalyptus, Natural forest, Soil seed bank, Fostering effect

Introduction

The diverse agro-ecological zones make Ethiopia to be called as a centre of biodiversity (Azene Bekele, 2007). And a highly diverse, ranging from afroalpine to desert vegetation (Haileab Zegeye *et.al,* 2005) which is estimated to include > 6,500 species of higher plants (12% endemic). About 35-40% of Ethiopia's land mass was covered by climax vegetation (FAO, 1981). However, over the last 3,000 years, there has been progressive deforestation, Rapid population growth, extensive forest clearing for cultivation, overgrazing, movement of political centers, and exploitation of forests for fuel wood and construction materials drastically reduced Ethiopia's forest area to 16 percent in the 1950s and to 3.1 percent by 1982 (FAO 2001).

Due to severe forest clearing and deforestation the country's forest resource becomes dwindling from time to time. Due to this, Eucalyptus tree was introduced by Emperor Menelik (1894−1895) to relieve the shortage of construction and fuel wood caused by the extensive deforestation (Pohjonen & Pukkala, 1990). Nowadays Eucalyptus is amongst the most successful tree species, being quickly adopted by farmers because of its fast growth, coppicing ability and less management requirements, the un-palatability of leaves, and their adaptability to a wide range of site conditions (FAO, 1982). Recent studies have showed that forest plantations can foster the regeneration of native woody species by catalyzing the succession processes (Feyra Senbeta *et.al*, 2001 and Getachew Tesfaye *et.al,* 2006). Eucalyptus tree plantations as an alternative site for the regeneration of native plant species (Feyera Senbeta *et al*., 2002). Plantations could also contribute to the conservation of biodiversity by providing an environment not only for native woody plants but also for the forest herb species (Boothroyd-Roberts *et al*., 2013). Plantation forests can provide habitat for a wide range of native forest plants and animals (Parrotta et al. 1997; Oberhauser 1997; Carnus *et al.* 2006; Hundera, 2010; Senbeta *et al*., 2002 and Koonkhunthod *et al*., 2007). Monitoring species composition, densities and the role of seed rain, soil seed banks and the regeneration potential of indigenous woody species following plantation establishment is of paramount importance. Regarding their productive importance Eucalyptus plantation have given huge attention on the protective of the local ecosystem by giving fostering effect to the soil seed bank flora and minimize the loss of natural forest by replacing as a fuel wood source. And this particular paper is intended to answer the effect of plantation forest on the diversity of indigenous woody plants and soil seed bank.

Materials and methods

The study was carried out at Qimbaba forest, located south west of Lake Tana (the source of the Blue Nile), in Bahir Dar Zuria woreda, Amhara National Regional State. Geographically located between $12^0$62'37"m and $12^0$65'31.6"m N latitude and $32^0$50'20"m and $32^0$78'76" m E longitude. Verisols and litosols was the dominant soil type. The temperature varies between 19^0C – 21^0C and receives an annual average of 1,272 – 1,397 mm

rainfall (Mekuriaw, 2013).

Plantation forests have been increased in the study area since the introduction of eucalyptus by Adiss-Bah project since 1974. Currently 967.50 ha of land in the study area were covered by forest of which 60.58% is plantation while the rest 39.32% is covered by natural forest. Of the plantation forests 19.53% are government forest under (AFE) while the majority 41.05% privately owned by the local community. The natural forest was dominated by shrub species of *Acokanthera schimperi, Calpurnia aurea* (alt) Benth., *Capparis tomentosa* and *Maytenus arbutifolia* in almost all parts of the forest and there is a high diversity of *Solanum gigantum* Jacq. Tree/shrub was also regenerated in the gaps that were created by expansion of stone crashers inside the forest. Whereas, big trees like *Ficus ovate* Vahl., *Sapium ellipticum* and *Syzygium guineense* were found along small streams inside the forest. Generally the forests were heavily disturbed by human induced factors.

Vegetation sampling

Vegetation assessment within the two stands (Eucalyptus plantation and natural forest) was conducted using a line transect survey. A circular plot with a size of 314 m^2 was established at 200 m intervals along line transect (in the east west direction) which was 200 m apart. The first transect and sample plot were aligned randomly at one side of each forest using a compass while the others were laid at 200 m intervals from each other. All sample plots were located at least 50 m far from the forest edges/road to avoid edge effect. In each plot, all of the naturally regenerated woody species were identified and counted. When identification proved difficult in the field, specimens were collected for identification. The plants were categorized as seedling (height ≤ 1.0 m), sapling (height between 1 and 3 m) and tree (height > 3 m). Hypsometer and calliper was used to measure height and diameter, respectively. For regeneration, trees which have <2 cm and height <2 cm are counted in each 40 sampling plots (20 in the natural and 20 in the plantation forest). Nomenclature follows honeybee flora of Ethiopia (Fichtl and Admasu, 1994) and flora of Ethiopia and Eritrea (Hedberg and Edwards 1995; Edwards *et al.,* 1995; Edwards et al., 2000; Hedberg *et al.,* 2006).

Soil sampling

To examine similarity of aboveground and soil seed bank flora, a total of 160 soil samples were collected with the depth of 3 cm difference (up to 9 cm) and the above soil layer. The soil seed bank samples were collected from the plots used for vegetation sampling. At the center of each plot, a small plot of 100 cm^2 was marked. The soil samples were put into plastic bags separately and transported for analysis. In cases of dissimilarity between soil and aboveground flora, soil depth was used to speculate the seed sources (whether recently dispersed seed or from soil seed bank) (Demel Teketay, 2001). All soil samples were sieved using a mesh size of 0.50 mm to recover seeds of woody species before the soil samples were incubated to stimulate germination of seeds. The seeds recovered by sieving were collected into paper bags and identified using local reference material. The viability of seeds was determined by dissecting/cutting seeds; seeds were considered viable when their contents were firm and white (Demel Teketay, 1996). The emerging seedlings were identified, recorded and discarded once every two weeks. Those seedlings difficult to identify were transplanted and grown to a larger stage to make identification easier and accurate (Feyra Senbeta *et. al,* 2001).

Data analysis

The natural and plantation forest species diversity and richness were calculated using the Shannon-Wienner diversity index (H') and Shannon evenness index (Peet, 1974 and Krebs, 1989). Structural data like population structure which is size distribution of the vegetation, height, and diameter frequency distribution of tree and shrubs, density of each naturally regenerated plants and eucalyptus plantations and the regeneration statuses of woody perennials in the plantation forest were analyzed were described in terms of frequency, dominance, basal area per hectare, important value index.

Results and discussion

Floristic composition and diversity

A total of 71 woody plant species belonging to 34 families were recorded in both the Eucalptus plantation and the natural forest. Of these 63 species were recorded in the natural forest and 33 species in the plantation forest. In the plantation forest, 48% trees, 45% shrubs and 7% climbers were counted while in adjacent natural forest, 60% trees, 32% shrubs and 8% climbers were identified. *Fabaceae* were the dominant families in the natural forest and *Fabaceae* and *Euphorbiaceae* in the plantation forest. The number of species recorded and identified in this study area (Eucalyptus plantation) were relatively low (Table 1).

Table 1. Comparison of number of woody species in different forest areas

No.	Forest name	No. of woody spp.	Remark
1	Jirren forest	40	Getachew Tesfaye *et. al,* 2006
2	Menagesha-Suba	37	Feyera Senbeta *et. al*, 2001
3	Munessa-Shashemene	55	Feyera Senbeta *et al*. 2002

Species diversity, richness and equitability

The Shannon diversity index of Qimbaba forest was found to be 2.08 and 3.19 for the plantation and natural forest respectively. The species encountered in the two forest types were distributed evenly as indicated by the Shannon evenness value of 0.59 and 0.77 for plantation and natural forest respectively. There was a good share of diversity among all quadrants.

Vegetation structure

Mean diameter and height

The result (Table 2) indicates that the mean diameter and mean height of native trees in eucalyptus plantation forest were relatively lower than the adjacent natural forest. In both forest types, the variances of DBH were lower than the variance of height because of the very high height variation in individual trees. It varies from 2-52m and 2-67m in Eucalyptus plantation and natural forest, respectively. Whereas, the variation of DBH were 2-30 cm for eucalyptus plantation forest and 2- 39 cm for the natural forest.

Table 2. Mean diameter and mean height of Qimbaba eucalyptus plantation and adjacent natural forest, Bahir dar Zuria woreda, West Gojam, Ethiopia

Variables	Forest type	Mean (±SE)	min	max	S^2	cof.var	SE
DBH (cm)	Plantation	5.8±0.35	2	30	29.03	0.92	0.35
Height (m)		5.9±0.45	2	52	46.95	1.15	0.45
DBH(cm)	Natural	7.22±0.17	2	39	26.9	0.71	0.17
Height (m)		8.14±0.28	2	67	72.52	1.04	0.28

Tree density of the forest

A total of 404 and 635 individuals per ha of woody plants from Eucalyptus plantation and natural forest, respectively were recorded. The five woody species with the highest density were *Calpurnia aurea, Solanum gigantum, Croton macrostachyus, Euclea racemosa* and *Bersama abyssinica* in the Eucalyptus plantation and *Acokanthera schimperi, Calpurnia aurea, Carissa edulis, Euclea racemosa* and *Solanum gigantum* in the adjacent natural forest.

Diameter distribution

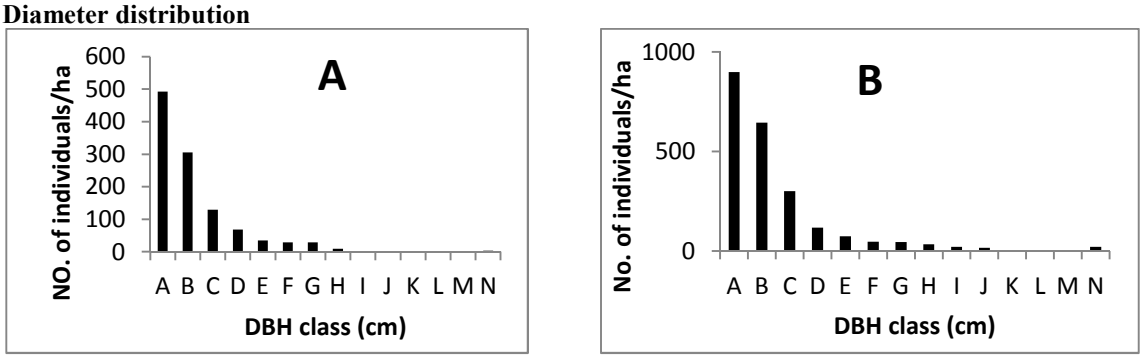

Figure 1. Diameter class distributions of woody species in Qimbaba eucalyptus plantation forest (A) and natural forest (B). Diameter class (A=0-3cm, B=3-6cm, C=6-9c m, D=9-12 cm, E=12-15 cm, F=15-18 cm, G=18-21 cm, H=21-24 cm, I=24-27 cm, J=27-30 cm, K=30-33 cm, L=33-36 cm, M=36-40c m, and N= >40

The diameter class distribution patterns resulted in an inverted J-shape. This is a general pattern of normal distribution (Didita *et al,* 2010). The natural forest was dominated by *Acokanthera schimperi, Calpurnia aurea*, and *Carissa edulis.* Whereas, the plantation forest is dominated by of *Calpurnia aurea, Solanum gigantum* and *Croton macrostachyus*. Generally this pattern of diameter distribution indicated that good regeneration status of the forest (Demel Tektay, 1997). Similar type of diameter distribution results were reported by Yinger *et al.,* (2008) in Bale mountain national park; Zegeye *et al.,* (2010) in Tara Gedam and Abebaye forests and Ambachew *et al*., (2014) in Wanzaye natural forest.

Height distribution

The height frequency distributions were categorized for the plantation forest and the adjacent natural forest.

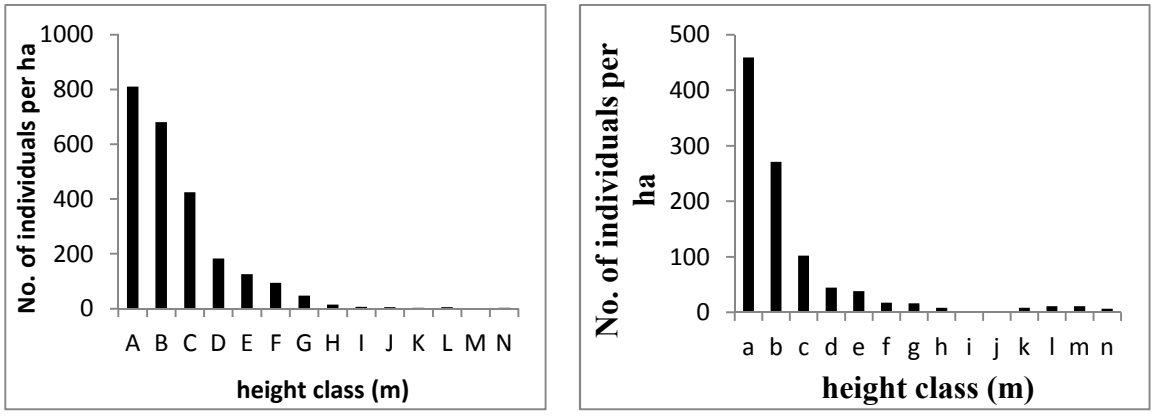

Figure 2. Height class distributions in Qimbaba NF (left side) and PF (right side). Height class (A=1-2m, B=2-5m, C=5-8 m, D=8-11 m, E=11-14 m, F=14-17 m, G=17-20 m, H=20-23 m, I=23-27 m, J=20-23 m, K=23-27 m, L=30-33 m, M=33-37 m and N=37-40

The two forests height distribution shows that an inverted J- shaped curve which shows lower height classes are higher in number and decrease as the height increases. This result, therefore, indicate that in the natural forest 62 % of the trees were in the class of < 5m, 26 % in the class between 6-11 m and the rest were in the higher height distribution class (Figure 9). While in the plantation forest 73 % of trees were in the class of < 5m, 14 % in the class between 6-11 m and the rest 13 % were in the higher height distribution class (Figure 2).

Basal Area

The basal area distribution is very important criteria for determining and classifying forest type based on maturation of the stand (Sokpon and Biaou, 2001). Total woody species basal areas of the forests were 4.9 m^2/ha and 24.5 m^2/ha for the native trees in the eucalyptus plantation and the adjacent natural forest, respectively. In the plantation forest, more than 75% of the basal area was shared by six species such as *Ficus sycomorus* (26%), *Grevillea robusta* (11.7%), *Cupressus lusitanica* (11.1%), *Croton macrostachyus* (8.8 %) and *Sapium ellipticum* (7.6 %). In the natural forest, Tree species that made the largest contribution to the basal area includes *Sapium ellipticum* (11.6%), *Ficus ovate* Vahl. (8.7%), *Bersama abyssinica* (6.3%), *Croton macrostachyus* (6.3%), *Mimusops kummel* (6.05%), *Ficus vasta* (4.9%), *Syzygium guineense* (4.6%), *Stereospermum kunthianum* (3.7%), *Acokanthera schimperi* (3.8%) *and Ficus sycomorus* (2.9%). When it was compared to the other forests;

Table 3. Comparison of basal area of woody species in different forest areas

Forest	BA/ha	Source
Tropical forest	35 m^2/ha	Midgley and Niklas, 2004
Zengena forest	22.3 m2/ha	Tadle et al., 2013
Hugumburda forest	9.23 m^2/ha	Ayenekulu, 2011
Wanzaye forest	23.3 m^2/ha	Ambachew, 2014
Boda dry ever green montane forest	114.6 m^2/ha	Erenso et al., 2014
Belete moist ever green montane forest	103.5 m^2/ha)	Gebrehiwot and Hundra, 2014

Important Value Index

Based on their IVI, the most important woody species in the natural forest with the highest important value index in decreasing order are: - *Acokanthera schimperi*, *Calpurnia aurea* (alt) Benth., *Carissa edulis* (forssek.) vhl, and *Sapium ellipticum* (table 4). Where as in the plantation forest *Calpurnia aurea (alt) Benth.*, *Ficus sycomorus*, *Croton macrostachyus*, *Solanum gigantum Jacq.*, *Euclea racemosa subsp. Schimperi*, *Grevillea robusta*, *Syzygium guineense*, *Cupressus lusitanica Mill*, *Sapium ellipticum*, *Bersama abyssinica subsp. Abyssinica* were dominant and the rest species only contribute 22% from the total IVI (table 5).

Table 4: IVI of Species in the natural forest (RF=Relative Frequency, RD=Relative Density, RDO=Relative Dominance and IVI=Importance Value Index)

No	Scientific name	RD	RF	RDo	IVI
1	*Acokanthera schimperi*	16.62	6.01	3.77	26.40
2	*Calpurnia aurea*	12.86	5.69	1.76	20.32
3	*Carissa edulis*	8.31	5.06	2.45	15.82
4	*Sapium ellipticum*	0.92	2.53	11.56	15.02
5	*Euclea racemosa*	7.38	5.37	2.08	14.85
6	*Croton macrostachyus*	3.23	3.79	6.30	13.33
7	*Bersama abyssinica*	3.56	2.84	6.37	12.78
8	*Solanum gigantum*	5.07	3.48	1.12	9.68
9	*Ficus ovate Vahl.*	0.32	0.63	8.65	9.61
10	*Capparis tomentosa*	3.95	4.74	0.58	9.28
11	*Others*	37.71	59.79	55.3	152.84

Table 5: IVI of Species in the plantation forest (RF=Relative Frequency, RD=Relative Density, RDO=Relative Dominance and IVI=Importance Value Index)

No	Scientific name	RD	RF	RDo	IVI
1	*Calpurnia aurea*	48.12	16.98	4.24	69.35
2	*Croton macrostachyus*	6.62	15.09	8.81	30.53
3	*Ficus sycomorus*	0.29	1.89	25.95	28.12
4	*Solanum gigantum Jacq.*	13.11	11.32	1.91	26.34
5	*Euclea racemosa*	6.19	6.60	3.01	15.81
6	*Grevillea robusta*	1.58	0.94	11.73	14.27
7	*Syzygium guineense*	1.15	1.89	11.11	14.15
8	*Cupressus lusitanica*	1.15	0.94	9.97	12.07
9	*Sapium ellipticum*	0.86	1.89	7.59	10.34
10	*Bersama abyssinica*	4.32	2.83	2.98	10.13
11	*Others*	16.57	39.62	12.65	68.84

Natural Regeneration

In the plantation forest there were 699 seedlings and 344 saplings/ha, While in the natural forest number of seedlings were 1117 and the number of saplings were 390/ha. When it was compared to others forests;

Table 6. Seedlings and sapling number of different forests in Ethiopia

Forests	Seedlings/ha		References
	NF	PF	
Wanzaye forest	2916		Ambachew *et al.,* 2014
Gera Ades	16290		Demel, 1997
Menagesha suba	32650		Demel, 1997
Belete forest	4500		Gebrehiwot and Hundera, 2014
Gedo dry montane forest	1068		Kebede *et al.,* 2014
Metema dry forest	120		Haile Adamu, 2009

There was a presence of more seedlings than saplings and mature trees, which indicates successful regeneration of forest species. Generally, most of the seedling and sapling were contributed by species such as *Acokanthera schimperi, Carissa edulis* (forssek.) vhl*, Calpurnia aurea* (alt) Benth., *and Croton macrostachyus* in the natural forest and *Calpurnia aurea* (alt) Benth., *Croton macrostachyus, Solanum gigantum* Jacq. and *Dodonaea viscose* in the eucalyptus plantation forest. The species richness in the eucalyptus plantation forest was 21 which was lower than other Afromontane forests of 33 woody species Mulugeta Lemenih *et al.,* (2004), Gara Ades forest (40) and 41 species of Mengesha forest (Demel Tektay, 1997) and Belete forest 60 species (Hundera, 2010). In the natural forest the species richness was 38 which was higher than Metema dry forest 26 species (Haile, 2009) and wanzaye forest 37 species (Ambachew, 2014). The most dominant species in the natural forest was *Acokanthera schimperi*, *Carissa edulis*, *Calpurnia aurea, Euclea racemosa* and *Capparis tomentosa*.

Diversity and Density of Soil Seed Bank

Species composition of soil seed banks

A total of 14 plant species representing 11 families were recorded from the soil seed bank, of these 12 species (10 families) were in the natural forest and 7 species (5 families) were found in the Eucalyptus plantation forest.

Trees were the dominant group represented by 8 species (57.2 %), while shrubs and climbers were represented by 5 species (35.7 %) and 1 species (7.1 %), respectively. This result is in agreement with the studies of Tinsae Assefa (2011) that reported the emergence of five woody plant species in the seed bank study, Bezawit forest at Abay Millennium Park, Northwest Ethiopia. *Acokanthera schimperi* was the dominant species, accounting to more than 80 % of the seed bank flora. This high number of seeds of *Acokanthera schimperi* in Qimbaba natural and plantation forest contradicts with other result of Feyera Senbeta *et. al* (2002); Eyob Tenkir (2006) and Degafi Sileshi *et. al* (2014). They reported *Juniperus procera* was the dominant species. Qimbaba forests were found in heavily populated area, where disturbance and expansion of quarries inside the forest aggravates the case. Studies like (Feyera Senbeta *et. al*, 2001 and Mulugeta Lemenih *et al*., 2004) have indicated, most woody species in the dry Afromontane forests of Ethiopia depend on seed rain and formation of seedling banks under the shades of mature forest canopy as strategies for regeneration.

Species Richness, Diversity and Evenness of Soil Seed bank

The Shannon diversity index for the diversity of soil seed bank in Qimbaba natural and Eucalyptus plantation forests were (H'=0.94 and H'=0.706), respectively (Table 7). These results are lower than Hgumbirda National Forest Priority Area (H'=1.763154) (Degafi Sileshi *et. al*, 2014) and Harenna forest (Getachew Tesfaye *et al.,* 2004).

Table 7. Soil seed bank species richness, diversity and evenness of Qimbaba forest.

Forest site	Soil layers	S	H'	E	Forest site	Soil layers	S	H'	E
NF	Litter layer	8	1.17	0.87	PF	Litter layer	3	0.46	0.42
	0-3 cm	4	0.68	0.49		0-3 cm	2	0.34	0.50
	3-6 cm	2	0.34	0.50		3-6 cm	2	0.27	0.39
	6-9 cm	2	0.27	0.39		6-9 cm	7	0.70	0.36
	Total	12	0.94	0.38		Total	3	0.46	0.42

The Shannon evenness index (E) had no consistence value among the soil layers of each forest site; but totally viewed as litter>0-3 cm>6-9 cm>3-6 cm. The overall SSB evenness of the eucalyptus plantation forest was 0.36, which is less than the adjacent natural forest evenness (0.36). This may be due to variation in seed rain and seed deterioration of different standing vegetation among the two forest sites (Perera, 2005, and Degafi Sileshi *et. al,* 2014). Likewise, difference in magnitude and intensity of disturbances could add up to the variation in diversity and evenness of SSB (Kellerman, 2004 and Degafi Sileshi *et. al*, 2014).

Similarity between Soil Seed Bank and Above Ground Flora

The similarity in species composition of the soil seed bank between the two forest sites was generally low with the JCS values of 0.208 (Table 8). These findings were low than other similar studies, (Eyob Tenkir, 2006) Dodola forest; Degafi Sileshi *et. al*, (2014) in Hgumbirda National Forest Priority area and Mulugeta Lemenih *et. al* (2006) they reported low JCS in tropical dry afromontane forests of Ethiopia.

Table 8. Sorenson's coefficient of Similarity in species composition of soil seed banks between the two forest sites of Qimbaba forest.

Gerebshihoita	*Plantation forest*	*Natural forest*
Natural forest	0.208	------
Plantation forest	-------	------

The similarity between the different soil layers was very low (JCS=0.0769-0.25) in the natural forest, where as in the Eucalyptus plantation forest, the similarity was lower between litter layer and 0-3 cm soil depth (JCS=0.111) and higher in the soil depth of 0-3 cm and 6-9 cm (JCS=0.2857). *Acokanthera schimperi,* was the abundant species in soil seed bank of Eucalyptus plantation forest and natural forest. The exotic species, *Eucalyptus camndulnsis* seed was heighest in the soil seed bank of Eucalyptus plantation forest compared to Mulugeta Lemenih and Demel Teketay (2006) who reported presence of *Eucalyptus globulus* in soil seed bank of Ethiopian afromontane forests. The presence of exotic woody species in soil seed bank flora may relatively become source of invasion and risk for future regeneration by competing and changing the ecosystem (Matthew *et al.,* 2004; Ferreira *et al.*, 2006).

Species Density of Soil Seed bank (SSB) Flora

The total seed density value in the upper nine centimeters with litter fall both from seedling emergence and seed counting method was 11,022 seeds/m^2 in the natural forest and 10,667 seeds/m^2 in the eucalyptus plantation forest. In the natural forest, 10,844.44 seeds/m^2 were viable and 177.56 seeds/m^2 were non-viable. Similarly, in the plantation forest 10311.11 seeds/m^2 were viable and 355.89 seeds/m^2 were non-viable collected from plantation forest. This result showed considerably lower density than Hgumbirda National forest Priority area (12,611.1 seeds/m^2) by Degafi Sileshi *et. al* (2014), in Dodola Dry Afromontane Forest (30,267 seeds/m^2) by

Eyob Tenkir (2006), in Menagesha-Suba and Munessa-Shashemene forest sites (ranged from 27,200 seeds/ m^2 to 82,600 seeds/m^2) by Feyera Senbeta *et. al* (2002) and in Gera Ades Moist Evergreen Afromontane Forest (10,333 - 93,293 seeds/m^2) by Yohannis Teklu (2014). In the natural forest, *Acokanthera schimperi* accounts over 80 % of the total soil seed bank. The same was true in the plantation forest which accounts 84 %.

Conclusion

In Qimbaba forest, a total of 71 woody species of trees and shrubs representing 34 families were recorded in both Eucalyptuses and the adjacent natural forest. Among the total species, two of them were exotic tree species (*Cupressus lusitanica and Grevillea robusta)*. The soil seed bank flora was composed 14 species in 11 families recovered 12 (in 10 families) species in the natural forest and 7 of them were in the Eucalyptus plantation forest (5 families). Qimbaba forest was the lowest basal area with the value of 4.9 m^2/ha and 24.5 m^2/ha for the plantation and the adjacent natural forest, respectively. Based on their important value index (IVI) *Acokanthera schimperi* was the highest (26.4), in the natural forest, and *Calpurnia aurea* was the higher (68.3), in *Eucalyptus* plantation forest. In the plantation forest, the regeneration status was 699 seedlings per ha and 344 saplings per ha. While in the natural forest it was 390 saplings/ha and 1117 seedlings/ha, with species richness in the eucalyptus plantation of 21 and 38 in the natural forest.

A total of 14 plant species representing 11 families were recovered from the soil seed bank, 12 (10 families) species in the natural forest and 7 (5 families) in the eucalyptus plantation forest. Trees were dominant and represented by 8 species (57.2 %), shrubs represented by 5 species (35.7 %) and climber 1 species (7.1 %) respectively. The total seed density both from seedling emergence and seed counting method was 11,022 seeds/m^2 in the natural forest and 10,667 seeds/m^2 in the eucalyptus plantation forest. *Acokanthera schimperi* accounts over 80 % and 84 % and of the total soil seed bank of natural forest and eucalyptus plantation respectively.

Recommendations

Based on the result, the following main recommendations are forwarded for improving the forest management in the study area:-

- To improve the regeneration of poorly represented native trees artificial regeneration by direct and enrichment planting for commercial multipurpose trees was recommended.
- Species with low important value index (IVI) needs high conservation work. Therefore, the management and conservation of those species should be given due attention with the collaboration of different actors and the community by ex-situ (preservation methods of their seeds, pollens and tissue culture) and in-situ (management of forest populations in the natural stand) conservation mechanisms.
- Conservation and promotions of fruit tree better establishment of the forest in their natural environment.
- There should be detailed study on the ethno botany of Qimbaba natural and native trees in the Eucalyptus plantation forest and Carry out further studies on socioeconomic importance, carbon emission amount of the forest for better conservation and sustainable management of the forest with the help of the local people.

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