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Assessment of Weed Flora Composition in Coffee (*Coffea arabica* L.) Farms at Buno Bedele and Ilu Abba Bor Zone, South Western Oromia, Ethiopia

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Abstract

Coffee (*Coffea arabica* L.), which is originated in Ethiopia, is the backbone of the country's economy. However, weed species are great challenges to decrease the yield and quality of coffee in the growing areas. Therefore, this activity initiated to determine composition of coffee weeds species in the study areas. Assessment was conducted in the selected districts of Buno Bedele and Ilu Aba Bora zones including Gachi, Chora, Didesa, Ale, Halu and Yayo. 0.5m x 0.5m quadrats size with zigzag sampling method was used. The result of this study revealed that the weed assessment fields were dominated by large number of weed species. Averagely across surveyed areas, the frequency value of the species was ranged from 13 – 89.9% and 33.3-95.1% at Buno Bedele and Ilu Aba Bora, respectively. The highest frequency value (89.9%) recorded by Justicia schimperiana followed Perilla frutescens (84.8%) at Buno Bedele zone, while in Ilu Aba Bora the highest frequency value (95.1%) was recorded by Bidens pilosa followed by Oplismenus hirtellus (94.2%) and Polygonum nepalense (93.7%). Whereas, the least frequency value recorded from Trifolium repens (40%), Crassocephalum rubens (13%), Cuscusta campestris (33%), Lantana camara (33%), Cynodon dactylon (33%) and Leucas martinicensis (40%) at both zones. The weed species compositions influenced by different districts. Thus, different weed management options would be required for the locations because of less than sixty percent (<60%) similarity indices were recorded from different locations of BunoBedele and Ilu Aba Bora zones. Generally from the results weed species were very important in production and productivity of coffee at the study areas. Thus there should be great considerations and practicing integrated weed management (IWM) is very important in order to reduce weed infestation with coffee farm in study areas.

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Keywords

Coffea arabica L., Weeds species, Abundance, Dominance, Frequency, Similarity index.

Introduction

Coffee (*Coffea arabica* L.), which is originated in Ethiopia, is the backbone of the country's economy. It accounts for 70% of the foreign exchange earning, 10% of the government revenue and employs 25% of the domestic labor force (Tsegaye *et al.,* 2000). It is the most important and valuable commodity in Ethiopia and in the world supporting the economic growth and providing job opportunity to millions of people. Traditionally, coffee trees are cultivated only for the berries, which are processed using dry or wet techniques directly in the growing areas to the final raw product green coffee; this serves as the basis for various coffee products (Taye and Tesfaye, 2002). However, the yield and quality of coffee affected by weed species (Tadese and Tesfu, 2015). In Ethiopia, the warm wet and humid conditions prevailing in the coffee growing areas of south west Ethiopia not

only result diverse weed flora ranging from soft annuals to extremely difficult to control perennials but also encourage the continuous growth of weeds all year round.

Weed competition, coffee growth, yield, and quality are seriously decreased and weed control is one of the largest tasks, which entails high cost (Ronchi & Silva, 2006 and Silva & Ronchi, 2008). Crop yield losses due to weed competition varied from 24% to 92% (Lemes *et al.,* 2010).

According to Tadesse (2015) yield loss as a result of weed competition can reach as high as 65 % to complete crop failure depending on the type of weeds, coffee growth stage and the prevailing growth conditions. Excluding environmental variables, yield loss in coffee is caused mainly by competition with weeds. Weed interference is a severe problem in coffee, especially in the early part of the growing years, due to slow early growth, narrow canopy, and wide row spacing.

Weeds compete with the coffee plants for resources such as light, nutrients, space, and moisture that influence the morphology and phenology of the crop. Furthermore, high weed infestation increases the cost of cultivation, lowers the value of land, and reduces the returns of coffee growers. These factors vary across regions and influence the composition and number of predominant weeds of economic importance to coffee production.

Therefore, assessment of weed composition, distribution and density is essential for a comprehensive understanding of the weed problem that poses negative impacts on coffee production in the study areas. Such assessment of the nature of weed flora determines, to a large extent, the type of weed management measures to be adopted.

To design effective weed control measures, identification and quantification of weed species are important steps. Information on weed density, distribution, and species composition may help to predict yield losses and such information helps in deciding whether it is economical to control a specific weed problem. But, in both Buno Bedele and Ilu Aba Bora zones there is poor information regards to weeds composition similarly, the relative importance of common weed species in coffee and cropping systems is not well documented in study areas. Hence, this work was done to assess weed flora composition in coffee growing belts of Buno Bedele and Ilu Aba Bora zones.

Materials and Methods

Description of study areas

Assessment was conducted in potential coffee growing areas of both Buno Bedele and Ilu Aba Bora zones. Depending on major coffee producing areas 6 districts were purposively used for this work. The selected districts were Gachi, Chora and Didesa from Buno Bedele zone and Ale, Halu and Yayo from Ilu Aba Bora zone. Geographical information was recorded by using GPS at the point of farm assessed (Table 1).

Coffee weed Assessment procedures

The assessment of the weed coffee in the study areas was carried out during the rainy season from June to September 2021. Ninety Coffee farms were assessed and other required data were collected. Each district was categorized into highland, midland and lowland. From each agro ecology 5 coffee farms were sampled within the interval of 3-5 km. At each farm a questionnaire was administered and the owner was asked about the age the tree, type of coffee species and weed species history. The factors which contribute in occurrence, distribution, frequency and dominance of weeds were identified. Weed population density and diversity was taken with quadrate size 0.5m × 0.5m area with the forwarding throwing method. Zigzag sampling method was used during the survey. Four to five quadrates were taken depending on farm size. Each and every weed species were counted manually and recorded.

Data analysis

The data on weed species composition was analyzed used by quantitative measurements including abundance (A), dominance (D), frequency (F) and similarity index (SI) determinations using the formula as follows described by (Thomas, 1985).

Frequency (F) = It is defined percentage of sampling plots (vegetation registrations) on which a particular weed species is found. It explains how often a particular weed species occurs in the survey area. Frequency was calculated for all weed species as follows:

$$F = \frac{X*100}{N}$$

Where, F= frequency of particular weed species; X= number of samples in which particular weed species occurs; N= total number of samples

Abundance (A) = It is defined as population density of a weed species expressed as the number of individuals of weed plants per unit area. This was calculated as follows:

$$A = \frac{\sum W}{N}$$

Where, A= abundance; ∑W= sum of individuals of particular weed species; N= total number of samples

Dominance (D) = is abundance of an individual weed species in relation to the total weed abundance (infestation level). It was measured as follows,

$$D = \frac{A * 100}{\sum W}$$

Where, D= dominance of particular weed species; A = abundance of the same species; ∑W = total abundance of all weed species

Similarity Index (SI): It is expressed as similarity of weed communities among different locations. It was calculated as follows

$$SI = 100 * Epg/(Epg + Epa + Epb)$$

Where, SI= similarity index; Epg = number of weed species found in all locations; Epa = number of species only in location a; Epb = number of species only in location b.

Results and Discussion

Status of Weeds in Coffee Farms at Buno Bedele and Ilu Aba Bora Zones

Weed Compositions at Buno Bedele and Ilu Aba Bora zones

Generally 35 weed species were identified from the surveyed 90 fields across surveyed districts. These weed species were distributed in 35 genera and 19 families. The majority of these weed species were fallen to broad leaves (22). In other way, 16 Annuals and 6 perennials, 4 grasses, 4 herbs, 2 shrubs, 2 parasite and 1sedge were recorded (Table 2). The most dominant families according to the frequency and number of weed species were Asteraceae, Poaceae, Lamiaceae, Amarantheae, Malvaceae and Solanaceae**.** Moreover, *Asteraceae*, Poaceae and Fabaceae were also found to be most important in other studies in the tropics (Getachew *et al.,* 2018). These families were also reported to be economically important and common in different parts of the country **(**Roger *et al.,* 2015).

Frequency of weed species at Buno Bedele and Ilu Aba Bora coffee growing belts during 2021

The weed assessment fields of Ilu Aba Bora and Buno Bedele zones were dominated by large number of species. This result shows weeds increased due to long duration of rain fall, fertilizer application and humidity which create conducive environment for its growth. Averagely over locations, the frequency value of the species ranged from 13 – 89.9% and 33.3 - 95.1% at Buno Bedele and Ilu Aba Bora respectively. The highest frequency value (89.9%) recorded by *Justicia schimperiana* followed by *Perilla frutescens (*84.8%) at Buno Bedele zone and the highest frequency value (95.1%) recorded by *Bidens pilosa* followed by *Oplismenus hirtellus* (94.2%) and *Polygonum nepalense (93.7%) at Ilu Aba Bora zones. Whereas, the least frequency value recorded from Trifolium repens (40%), Crassocephalum rubens* (13%), *Cuscusta campestris* (33%), *Lantana camara* (33%), *Cynodon dactylon* (33%) and *Leucas martinicensis* (40%) at both zones (Table 3). Most of coffee fields of the study areas occurred by annual weeds rather than perennials. This result line with (Begum, 2008) who reported that different frequencies of different weed species including broad leaves, grasses, and sedges. Most of the common weeds in all surveyed areas were found in annual nature followed by perennials.

Abundance of weed species in Buno Bedele and Ilu Aba Bora coffee growing belts during 2021

The results showed that from 35 weed species the averagely range of weed abundances were from 2.7- 25.5 at Ilu Aba Bora and 3.4 – 22.4 at Buno Bedele zone. The highest abundance value (25.5) was recorded by *Polygonum nepalense* followed by *Trifolium repens* (22.8) and (22.6) was recorded by *Portulaca oleracea*. Whereas, the least abundance value (2.7) was recorded for *Argemone mexicana* L. at Ilu Aba Bora zone. While, the highest abundance value 22.4, 19.1, 16.5 were recorded by *Perilla frutescens, Justicia schimperiana* and *Cyperus esculenta* respectively, whereas the least abundance value 3.5 recorded by *Cynoglossum lanceolatum* at Buno Bedele zone (Table 3). From this results most abundant weed species were Broadleaf then grasses, shrubs and herbs were occurred in both zones.

Table.1 Weather conditions of assessed districts of Buno Bedele and Ilu Aba Bora zones during 2021

Districts	Altitude (m.a.s.l)	Latitude N	Longitude E	Rainfall (mm)	Min.Temp. (ºC)	Max.Temp (ºC)
Ale	1648-2377	8º02'0.00"	35º39'59.99"	1982	14	19
Chora	1470-2516	8º19'60.00"	36º14'60.00"	1350	9	31
Didesa	1428-2512	8º04'60.00"	36º39'59.99"	1800	13	28
Gachi	1363-2553	8º19'60.00"	36º39'59.99"	1100	13	18
Halu	1370-1917	8º8'51.26"	35º20'27.74"	1450	18	24
Yayo	1304-2587	8º20'35.09''	35º48'58.83''	2300	7	32

Figure.1 Map of the study area

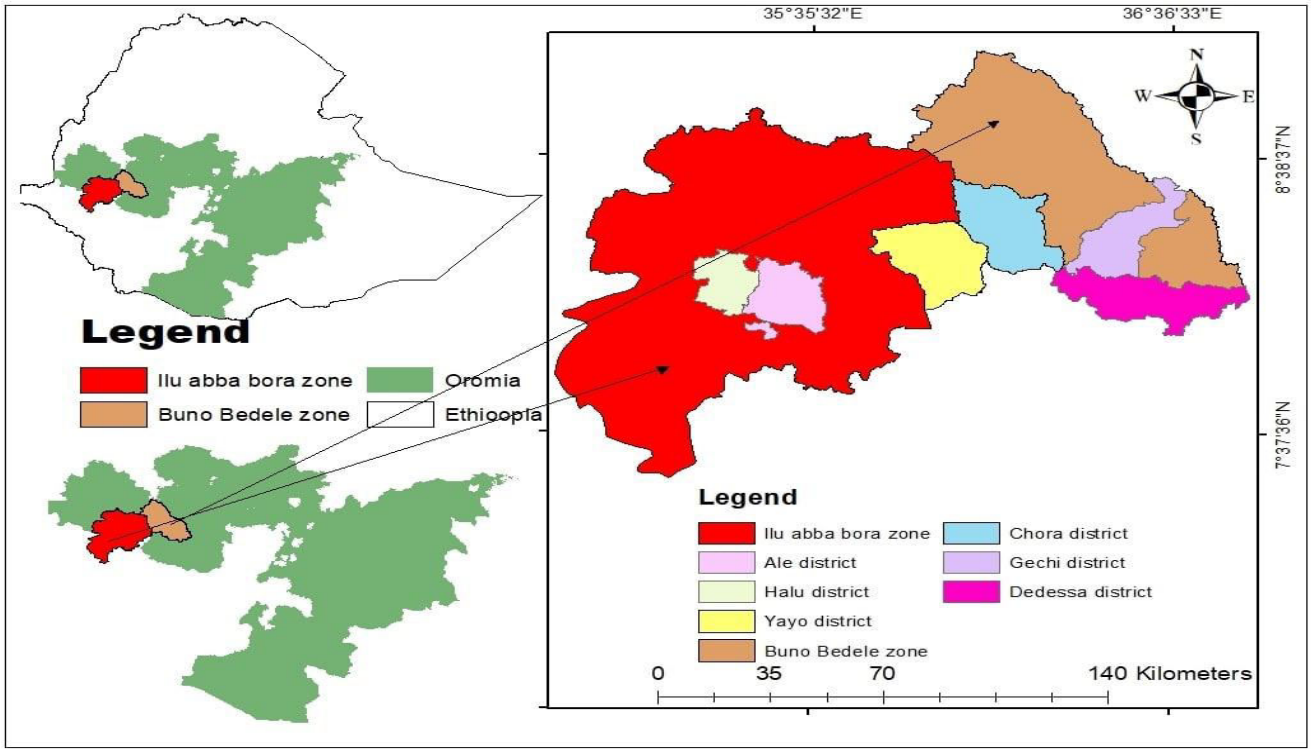

Table.2 Weed Species Composition Descriptions at Buno Bedele and Ilu Abba Bora Zones during 2021 Weed Survey

№	Families	Common name	Scientific name	Life Cycle and Morphology
1	Acanthaceae	-	*Justicia schimperiana*	Perennial Shrub
2	Amaranthaceae	Devil's Horsewhip	*Achyranthes aspera*	Perennial Broadleaf
3	Amaranthaceae	Spiney pigweed	*Amaranthus spinosus*	Annual Broadleaf
4	Asteraceae	Billy goat	*Ageratum conyzoides*	Annual Broadleaf
5	Asteraceae	Canada Thistle	*Cirsium arvense*	Perennial Broadleaf
6	Asteraceae	Dandelion	*Taroxacum officinale*	Perennial Herb
7	Asteraceae	Goat weed	*Ageratum conyzoides*	Annual Broadleaf
8	Asteraceae	Black Jack	*Bidens pilosa*	Annual Broadleaf
9	Asteraceae	-	*Crassocephalum rubens*	Annual Broadleaf
10	Asteraceae	Gallant Soldier	*Galinsoga parvilov*	Annual Broadleaf
11	Asteraceae	GuzotiaScabra	-	Annual Broadleaf
12	Boraginaceae	Cynoglossum	*Cynoglossum lanceolatum*	Annual Broadleaf
13	Commelinaceae	Tropical spiderwort	*Commelina benghalensis* L.	Annual Broadleaf
14	Convolvulaceae	Dodder	*Cuscusta campestris*	Parasite
15	Cyperaceae	Sedge	*Cyperus esculenta*	Sedge
16	Euphorbiaceae	Wild Poinsettia	*Euphorbia esula*	Annual Broadleaf
17	Fabaceae	Clover	*Trifolium repens*	Perennial Herb
18	Lamiaceae	Ground Ivy	*Glechoma hederacea*	Perennial Broadleaf
19	Lamiaceae	Bobbin Weed	*Leucas martinicensis*	Annual Broadleaf
20	Lamiaceae	Damakase	*Ocimum lamilifolium*	Perennial Broadleaf
21	Lamiaceae	Shiso/beefsteak	*Perilla frutescens*	Annual Herb
22	Lamiaceae	Meskel Flower	*Bidens pachyouma*	Annual Broadleaf
23	Malvacea	Chinese jute	*Abutilon theophrasti*	Annual Broadleaf
24	Malvacea	-	*Sida rhombifolia*	Perennial Broadleaf
25	Orobanchaceae	Yerba sosa	*Orobanche ramose* L.	Parasite
26	Poaceae	African Coach Grass	*Digitaria abyssinica*	Perennial Grass
27	Poaceae	Bermuda grass	*Cynodon dactylon*	Perennial Grass
28	Poaceae	Basket Grass	*Oplismenus hirtellus*	Perennial Grass
29	Poaceae	Ethiopian Grass	*Snowdenia polystachya*	Perennial Grass
30	Polygonaceae	Snake weed	*Polygonum nepalense*	Annual Broadleaf
31	Portulacaceae	Purslane	*Portulaca oleracea*	Annual Broadleaf
32	Solanaceae	Thorn Apple	*Datura stramonium*	Annual Broadleaf
33	Solanaceae	Wild Egg Plant	*Solanum xanthocarpum*	Perennial Herb
34	Urticaceae	Himalayan nettle	*Girardinia diversifolia*	Annual Broadleaf
35	Verbenaceae	Lantana Camara	*Lantana camara* L.	Perennial Shrub

Table.3 The Quantitative Weed Species composition in Buno Bedele and Ilu Abba Bora rainy season during 2021

№	*Scientific Name*	Frequency		Density		Abundance		Dominance	
		BB	IAB	BB	IAB	BB	IAB	BB	IAB
1	*Abutilon theophrasti*	63.5	66.7	4.6	3.5	6.9	5.4	4.6	2.6
2	*Achyranthes aspera*	68.6	72.7	2.7	7.3	4.2	9.7	2.9	5.7
3	*Ageratum conyzoides*	60.0	77.8	3.8	14.6	5.9	19.0	3.8	9.7
4	*Amaranthus spinosus*	69.2	87.9	8.0	12.5	10.8	13.7	7.2	8.7
5	*Argemone mexicana* L.	66.7	69.1	2.6	1.9	4.2	2.7	2.9	1.6
6	*Bidens pachyouma*	60.0	66.7	5.4	9.6	10.2	14.1	7.0	7.0
7	*Bidens pilosa*	80.7	95.1	9.9	19.8	11.6	20.8	10.5	15.0
8	*Cirsium arvense*	0.0	0.0	0.0	2.0	0.0	3.7	0.0	1.4
9	*Commelina benghalensis* L.	68.2	82.2	5.2	8.6	7.3	9.9	5.9	6.2
10	*Crassocephalum rubens*	13.0	66.7	6.0	7.4	6.0	12.1	5.6	5.1
11	*Cuscusta campestris*	66.7	33.3	4.2	3.3	6.4	10.0	5.0	2.2
12	*Digitaria abyssinica*	83.4	58.3	5.3	2.4	6.0	4.3	7.0	1.9
13	*Cynodon dactylon*	33.3	0.0	3.7	0.0	11.0	0.0	3.9	0.0
14	*Cynoglossum lanceolatum*	66.7	57.2	2.1	3.8	3.4	6.5	2.6	2.7
15	*Cyperus esculenta*	66.7	70.4	11.5	5.7	16.5	7.3	8.7	3.8
16	*Datura stramonium*	73.4	50.0	3.5	4.2	4.4	8.3	4.3	3.1
17	*Euphorbia esula*	65.4	76.2	4.5	9.2	6.8	11.4	5.4	7.2
18	*Galinsoga parvilov*	69.8	87.9	8.4	13.0	12.2	14.8	10.3	9.8
19	*Girardinia diversifolia*	61.9	79.2	7.0	7.0	10.2	8.2	6.8	4.5
20	*Glechoma hederacea*	73.6	92.2	10.7	18.2	13.6	19.3	11.2	13.9
21	*Guizotia scabra*	51.8	88.9	6.5	11.5	12.6	13.3	7.6	8.9
22	*Justicia schimperiana*	89.9	88.1	18.2	19.2	19.1	22.0	18.9	18.0
23	*Lantana camara*	0.0	33.3	0.0	3.7	0.0	11.0	0.0	2.8
24	*Leucas martinicensis*	40.0	66.7	3.3	7.0	8.9	10.3	2.8	4.7
25	*Ocimum lamilifolium*	66.7	66.7	5.8	8.2	8.5	9.5	4.2	5.9
26	*Oplismenus hirtellus*	79.8	94.2	8.9	19.7	11.4	20.8	10.0	15.2
27	*Orobanche ramosa* L.	66.7	0.0	8.3	0.0	12.5	0.0	10.5	0.0
28	*Perilla frutescens*	84.8	85.1	19.2	17.9	22.4	20.3	22.7	13.4
29	*Polygonum nepalense*	73.9	93.7	10.3	24.8	13.7	25.8	9.9	14.8
30	*Portulaca oleracea*	72.2	83.3	9.5	20.2	13.5	22.6	9.8	14.1
31	*Sida rhombifolia* L.	51.5	66.7	2.1	2.7	4.4	4.1	2.3	2.0
32	*Snowdenia polystachya*	66.7	70.4	4.3	7.8	6.5	11.3	6.2	5.2
33	*Solanum xanthocarpum*	56.0	63.0	2.6	2.7	4.0	4.4	2.8	2.1
34	*Taroxacum officinale*	0.0	62.7	0.0	4.4	0.0	6.5	0.0	3.3
35	*Trifolium repens*	40.0	44.4	3.3	8.6	9.2	22.8	4.7	6.5

Table.4 Similarity index of weed species at three districts of Buno Bedele Coffee growing areas

Districts	Gachi	Chora	Didesa
Gachi	100.0	37.5	36.3
Chora		100.0	36.7
Didesa			100.0

Table.5 Similarity index of weed species at three districts of Ilu Abba Bora Coffee growing areas

Districts	Ale	Halu	Yayo
Ale	100.0	36.5	40.0
Halu		100.0	37.8
Yayo			100.0

Note: - Similarity indices between both zone districts were less than sixty percent (<60%)

Weed species field density in Buno Bedele and Ilu Aba Bora coffee growing areas during 2021

The top ten of weed species field density at the study areas was recorded with *Polygonum nepalense* (24.8), *Portulaca oleracea* (20.2), *Bidens pilosa* (19.8), *Oplismenus hirtellus* (19.7), *Justicia schimperiana* (19.2), *Perilla frutescens* (19.2), *Glechoma hederacea* (18.2), *Ageratum conyzoides* (14.6), *Galinsoga parvilov* (13.0) and *Amaranthus spinosus* (12.5) were recorded. The lowest result (1.9) was recorded by *Argemone mexicana* L. at the study area (Table 3).

This field density varied from district to district and even from kebele to kebele, farm to farm. Unlike field, density has resulted due to some factors like weed managements practiced by growers including cultural, mechanical, chemical and so on, biological including eaten by wild animals, birds, insects, over dominated by anther weed species and etc., physically like poor germination, soil pH, soil moisture stress and etc.

Dominance of weed species at Buno Bedele and Ilu Aba Bora coffee growing areas during 2021

The results showed that from assessment areas the weed dominance ranged between 22.4% and 1.6% which was recorded by *Perilla frutescens* and *Argemone mexicana* L., respectively (Table 3). Weed species *Perilla frutescens* (22.4), *Justicia schimperiana* (18.9), *Glechoma hederacea* (11.2) were occurred most dominantly in Buno Bedele coffee growing areas, while *Justicia schimperiana* (18.0) *Oplismenus hirtellus* (15.2) and *Bidens pilosa* (15.0) were occurred dominantly in Ilu Aba Bora zones during 2021 coffee growing season.

Similar results were found from Gidesa *et al.,* (2016) reported that if the specific plant species had higher dominance value, it indicate the economic importance of it. Therefore, this study confirmed that *Perilla frutescens* and *Justicia schimperiana* species are the major social, environmental and economic threats in the study area.

Effect of Different Management Practices on Weed Species Occurrences and Distributions

The survey results showed that the current status of management practices in the study areas was visually observed. The present study identified the cultural practices (Slashing, hoeing, hand weeding, mulching, cropping systems, soil fertility) which had contributions in the abundances and occurrences of weed species.

During survey time, most of farmers coffee field was exposed to weeds due to lack management. According to many farmers, there are no weeds affecting coffee yield and also they only slashing the weeds when they are ready to harvest.

Depend on this reason; the variation was observed in abundance, dominance and frequency of weed species in the study areas. Some factors including farmer's practices, agro-ecology, soil types and climatic conditions were made vary in case of weed quantitative measurements.

This result was agree with the findings of Mennan and Isik (2003) who reported that difference in field management practices applied to the different survey strata could be the cause vary in distribution, abundance and dominance of the weed species.

Similarity Indices

Similarity index is the similarity of plant species composition among different districts in two Zones. The result showed a similarity index value of 36 - 38% and 36 - 40% among the districts of Buno Bedele and Ilu Aba Bora zones respectively (Table 4 & 5). As described by (Begum, 2008), if the index of similarity is below 60%, it is said that the two locations have different weed communities. The weed species composition was dissimilar between districts of both zones noted that weed growth, population density and distribution vary from place to place depending upon soil and climatic factors that affect the weed species and farmers management practices. Thus, different weed management options would be required for the locations differing in weed flora composition, while all surveyed areas had shown the similarity indices less than sixty percent (<60%).

Conclusion and Recommendation

A total of 35 coffee weed species belongs to 19 families were identified. The large majority of these, 22 were fallen to broad leaf species from this 16 Annuals and 6 (Six) perennials. While, the remaining species fallen to grasses (4), herbs (4), shrubs (2), Parasite (2) and sedge (1).

The occurrences and distributions of some weed species is influence due to management practices, agro ecologies and shade conditions in the study areas.

Weed species composition also varied between and within the locations in zones at all surveyed areas. Thus, different weed management options would be required for the locations differing in weed composition, while all surveyed areas had shown the similarity indices less than sixty percent (<60%). Further identification of weed species composition, characteristics, competition, and flora shift is necessary to adopt effective weed management options.

Therefore, coffee producers or growers should consider time of weed competition with the crops and controlling time.

The importance of appropriate and readily available practices for weed control should be overemphasized for increasing of coffee production and enhancement of harvesting hard currency. The weed control methods of (cultural, physical, biological, chemical etc.) should be combined in an integrated weed management strategy (IWM).

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