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Survey of weed flora in sugarcane fields of Tana Beles sugar development project; Ethiopia

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Keywords

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Weed Species,
Weed Survey.

Abstract

Survey of weed flora was carried out on 30 fields of Tana Beles Sugar Project during 2016 with the objective of evaluating the prevalence and distribution of weeds under the existing agro-ecological conditions Tana beles sugar development project. The fields were stratified into soil types (light and heavy), crop type (plant cane, ratoon and other crop (soybean)) and further in to varieties (NCO334 and N14). Three fields were surveyed in each stratum and a total of 310 samples were taken in whole survey. This was done at early growth stage (25-30 days after planting) for plant cane and soybean as well as one week before fertilization for ratoon cane fields using 0.25 m^2 quadrant following a pattern of inverted "W" continuously for every 2.5–3 ha. Weed species in each quadrant were collected and identified species wise. A total of 148 weed taxa were identified belonging to 31 families. The most important weed species with respect to their Important Value Index (IVI) were found to be *Brachiari aciliaris, Commelina benghalensis, Commelina diffusa, Commelina latifolia, Cynodon dactylon, Cyperus rotundus, Digitaria abyssinica, Eleusine indica, Panicum dichotomiflorum* and *Rottboellia cochinchinensis.* Moreover, all strata were infested by different weed communities leading for proper designation of weed management strategies that consider each strata independently should be made. Therefore, planning of weed control strategy in the future should take these weed diversity in to consideration.

1. Introduction

Sugar industry development in Ethiopia has great contribution to the development of the livelihood of the society and the national economy in many ways. The demand of the society for sugar is highly increased in all directions of the country. Therefore, the government of the country had shown a high need to increase the production and productivity of sugarcane to satisfy the interest of the society in the country by initiating new projects and upgrading the existed sugar factories. But, the yield of sugarcane reduced from time to time due to different constraints.Weeds, diseases and insect pests are among the major constraints of sugarcane cultivation in Ethiopian (Abera and Tesfaye, 2001). However, weeds are the major cause for high cost and yield reduction in sugar cane production. Although different weeds may be superficially very similar, they differ in their growth habit, reproductive habit and responses to individual control methods (Memon *et al*., 2013). To design effective weed control measures; identification, characterization and quantification of weeds in a certain area are important steps to be followed (Firehun, 2004). Therefore, this survey was conducted with the objective of evaluating the prevalence and distribution of weed flora under agro-ecological conditions of Tana Beles Sugar Development Project plantation estate that helps to design effective weed management strategy.

2. Materials and Methods

2.1. Site Description

The study was done in Beles sugar development project, which is found in an altitude of 1119 m.a.s.l in Amhara and some part of Benshangulgumuz regional states of Ethiopia. The average annual rainfall of Beles sub-basin is 1490 mm. The minimum and maximum temperature of the area is between 16.4 and 32.5 ^{0}C, respectively (Zeleke and Netsanet, 2015). There are two main soil types i.e., heavy soil and light soil. Majority of the plantation area is covered by heavy soil.

2.2. Weed flora assessment

Purposive sampling technique was used following inverted 'W' pattern as suggested by Thomas (1985) using (0.25 m^2) quadrant for every 2.5–3 ha. Number of samples per hectare was determined by species-area curve and site condition as suggested by Taye and Yohannes (1998). Plantation fields of the estate were stratified in to soil types (light and heavy) and furthely stratified in to plant cane, ratoon cane and other crop (soybean) where prominent sugarcane varieties of the plantation (NCO334 and N14) were used for both cuttings. Three fields were surveyed in each stratum.

The survey was done during 25-30 DAP for sugarcane plant and soybean fields and a week before fertilization for ratoon fields and samples were collected using quadrant. During survey, all the weeds present in each quadrant were removed, collected and kept separately in polythene bags for species wise separation and counting. Following this, the collected weed species were then identified. For perennial grass weeds or herbaceous species, the number of shoots rather than the number of plants were counted. But, for annual grasses the tillered annual grass (rooted individuals) were counted as a single plant regardless of the number of tillers. Weeds that were difficult to identify were pressed and tagged on hard papers and then was submitted to Wonji research center for identification. The remained weeds were taken to Addis Ababa University for identification. The weeds were counted, identified and separated by species wise using the available weed identification guides (McIntyre, 1991) and were recorded in species wise per each m^2 area. Nomenclature of the available weed species were also done following the flora of Ethiopia and Eritrea, volume 2, 3, 4, 6, and 7 (Hedberg *et al.*, 2003).

The data on weed survey was summarized and frequency, abundance, dominance, density, relative density, relative abundance, relative frequency, important index and similarity index values of the identified weeds were calculated using the formula described by Taye and Yohannes (1998). All the collected data were calculated by using MS-Excel.

3. Results and Discussion

3.1. Composition and diversity of weed species

A total of 145 weeds were identified at species level which were further grouped in to 31 families and 93 genera whereby each family contained 1 up to 40 weed species (Table 1 and 2). Firehun and Tamado (2007) aslso reported total of 180 weed taxa belonging to 40 families in wonji-shoa and Metahara sugarcane plantations.

Based on the life cycle of weeds, 47 (32%) and 101 (68%) species were found to be perennials and annuals respectively. Similar weed floral composition was reported by Yohannas *et al*. 2014 on most irrigated farms. The occurrence of annuals at higher level is due to the problem that weeding was started much delayed that most of the annual weeds were well grown. Soils of Tana Beles plantation fields contained high weed seed. Due to high moisture and continuous rainfall in the area, these weed seeds germinated but not removed on time.

Furthermore based on their morphological classification; 99 weed species (67%) were broad leaved. These were the major weeds followed by 40 species of grasses (27%) and sedges with 9 weed species (6%). Among the broad leaved species, two weeds (*Striga hermontica* (Del) Benth and *Striga aspera* (Wild) Benth) were parasitic weeds. In Ethiopia, *Striga hermontica* was reported to be prevalent in the sugarcane plantations of Fincha (Birhanu, 1993).

The survey also indicated that dicotyledonous species (67%) were dominant than monocotyledonous (33%) in the plantation estate. This might be due to less cultivation of the fields. Because, plantation of cane and sowing of soybean in the study area were done after one time cultivation followed by furrowing. Hyvonen *et al*. (2003) also reported that low input cultivations expected to favor the species numbers and abundance of dicotyledonous weeds.

Out of 31 families 14 were monotypic, viz., contained only one species. These are Acanthaceae, Boraginaceae, Caesalpiniaceae, Capparidaceae, Labiatae, Malvaceae, Plantaginaceae, Portulacaceae, Primilaceae, Robiaceae, Sphenocleaceae, Spindaceae, Verbenaceae and Zygophyllaceae. Nigaraju *et al*. (2014) also reported Among these, Boraginaceae, Caesalpiniaceae, Robiaceae, Spindaceae, Verbenaceaeana, Zygophyllaceae as monotypic weed families in India.

Based on the number of taxa contained, 11 dominant families were identified, viz., Gramineae (40), Compositae (22), Fabaceae (11), Convolvulaceae (9), Cyperaccea (9), Amaranthaceae (7), Euphorbiaceae (7), Solanaceae (6), Commelinaceae (4), Ayzoaceae (3) and Cucurbitaceae (3) constituted a total of 121 weed species that accounts 81.75% of the total weed flora (Table 2).

Table 1: Order, Family, Richness and relative diversity of weeds in sugarcane and soybean fields

Order	Family	Richness	Relative diversity
1	Acanthaceae	1	0.68
2	Amaranthaceae	7	4.73
3	Ayzoaceae	3	2.03
4	Boraginaceae	1	0.68
5	Caesalpiniaceae	1	0.68
6	Capparidaceae	1	0.68
7	Caryophyllaceae	2	1.35
8	Chenopodiaceae	2	1.35
9	Compositae	22	14.86
10	Commelinaceae	4	2.7
11	Convolvulaceae	9	6.08
12	Cucurbitaceae	3	2.03
13	Cyperaccea	9	6.08
14	Euphorbiaceae	7	4.73
15	Fabaceae	11	7.43
16	Poaceae	40	27.03
17	Labiatae	1	0.68
18	Liliaceae	2	1.35
19	Malvaceae	1	0.68
20	Plantaginaceae	1	0.68
21	Polygonaceae	2	1.35
22	Portulacaceae	1	0.68
23	Primilaceae	1	0.68
24	Robiaceae	1	0.68
25	Scrophulaiaceae	2	1.35
26	Sphenocleaceae	1	0.68
27	Spindacea	1	0.68
28	Solanaceae	6	4.05
29	Tiliaceae	3	2.03
30	Verbenaceae	1	0.68
31	Zygophyllaceae	1	0.68
	Total	148	100.02

Therefore, Gramineae (Poaceae) was the largest family in the plantation area with 40 species followed by Compositaea and Fabacea with 22 and 11 species respectively (Table 1 and Table 2). This might be due to the high grass weed seed bank of soil in the plantation fields and they are in the same family with sugarcane. This is similar with the result of Firehun *et al.* (2008) as they reported Poaceae (Graminae), Fabaceae, Asteraceae (Compositae), Euphorbiaceae and Convolvoceae as the dominant families that accounted for 51% of the total weed families in Finchaa sugarcane plantation of Ethiopia

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Table 2: Weed family, their richness and proportion percentage of eleven diverse families during the study period

Order	Family	Richness	% of total flora
1	Amaranthaceae	7	4.73
2	Ayzoaceae	3	2.03
3	Compositae	22	14.86
4	Commelinaceae	4	2.7
5	Convolvulaceae	9	6.08
6	Cucurbitaceae	3	2.03
7	Cyperaccea	9	6.08
8	Euphorbiaceae	7	4.73
9	Fabaceae	11	7.43
10	Gramineae/ Poaceae	40	27.03
11	Solanaceae	6	4.05
	Total	**121**	**81.75**

It was also reported that weeds belonging to the families Poaceae, Asteraceae and Fabaceae were the most important in arable fields of eastern Ethiopia (Tamado and Milberg, 2000). Among the dominant weed families in TanaBeles sugarcane plantation, four of them (Poaceae, Asteraceae, Euphorbiaceae, and Fabaceae) were also recorded as the most important weed families in sugarcane plantations of Coimbatore (India), Louisiana, Mauritius, and China (Lianming and Chuxiong, 2003). These families are very rich in species diversity so it is usual that they contain many weeds.

Hidalgo *et al*. (1990) reported that flora diversity is estimated to be high if the average number of species per field were greater than 19. But, in this study, diversity of flora in each field varied from 21 to 57 (mean= 39) which is high. This might be due to high soil weed seed bank, high and frequent rainfall with warm weather conditions and high fertilization. Moreover, Pulschen (1990) described the botanical family to be regarded as highly diversified; it should contain more than five species. In this study, 8 families were most diversified and contributed about 111 species which is 74.99%. The families Compositae, Convolvulaceae, Cyperaccea, Fabaceae and Poaceae were the richest taxa accounted for 91 species which is above half (61.48%) of the whole flora in the plantation site (Table 1 and Table 2).

At the genus-level, diversity was almost three times higher than that of at the family level. From the recorded 148 taxa of 93 genera, 10.76% of them contained three to seven species; the genus *Cyperus* being the most diverse taxa with seven species followed by *Brachiaria* and *Amaranthus* with each six species and *Euphorbia* with five species (Appendix 1). In Ethiopia the prevalence of *Cyperus* species was first reported by Holm *et al. (*1977*).* These species were found as the most dominant species in almost all the surveyed soil types of sugarcane fields in Ethiopia (Firehun, 2004).

3.2. Frequency, abundance and dominance of weeds

According to their IVI in descending order, the top 10 weeds were: *Eleusine indica*, *Cyperus rotundus*, *Commelina benghalensis*, *Commelinalatifolia*, *Panicumdichotomiflorum*, *Commelina diffusa*, *Brachiariaciliaris*, *Digitaria abyssinica*, *Rottboellia cochinchinensis* and *Cynodon dactylon* in the plantation site irrespective of soil type, crop type, sugarcane crop types and cane varieties (Table 3). Among these weeds, *Cyperus*s pecies and *Commelina latifolia* were reported as major weed species having a higher dominance level in Wonji-Shoa sugarcane plantation estate irrespective of soil and crop types (Firehun and Tamado, 2007).

Table 3: Frequency, Abundance, Dominance, Density, Relative Frequency, Relative Abundance, Relative Density and Important value index of most important weeds at sugarcane and soybean fields

Species	TS	F	A	D	De	RF	RDe	RA	IVI
*Acalyphacrenata*A.Rich	310	3.87	0.34	1.29	0.34	1.09	1.29	1.29	3.67
Achyranthesaspera(L)	310	5.48	0.58	2.2	0.58	1.55	2.19	2.19	5.94
Allium vineale	310	6.13	0.22	0.82	0.22	1.73	0.82	0.82	3.37
*Amaranthusretroflexes (*L).	310	4.84	0.29	1.11	0.29	1.37	1.1	1.1	3.57
Bidensbiternata (L).	310	3.55	0.21	0.81	0.21	1	0.81	0.81	2.62
Brachiariaciliaris	310	6.77	1.35	5.15	1.35	1.91	5.14	5.14	12.18
Brachiariacrusgalli	310	3.55	0.65	2.49	0.65	1	2.48	2.48	5.95
Brachiarapaspaloid	310	4.19	0.71	2.71	0.71	1.19	2.7	2.7	6.58
Centrosemapubescens	310	4.19	0.39	1.48	0.39	1.19	1.47	1.47	4.13
*Commelinabenghalensis (*L).	310	20.65	1.61	6.15	1.61	5.83	6.13	6.13	18.09
Commelinadiffusa	310	8.39	1.3	4.96	1.3	2.37	4.94	4.94	12.25
*Commelinalatifolia*A.Rich.	310	9.03	1.45	5.55	1.45	2.55	5.53	5.53	13.61
Cynodondactylon (L.) Pers.	310	8.39	0.85	3.24	0.85	2.37	3.22	3.22	8.82
Cyperusesculentus(L)	310	11.29	0.1	0.38	0.1	3.19	0.38	0.38	3.95
Cyperusrotundus (L).	310	30.32	2.8	10.69	2.8	8.57	10.65	10.65	29.87
Digitariaabyssinica (A. Rich) Stapf.	310	7.74	1.22	4.66	1.22	2.19	4.65	4.65	11.48
Digitariasanguinalis (L.) Scop.	310	2.9	0.39	1.49	0.39	0.82	1.48	1.48	3.79
Echinochloacolona (L.) Link.	310	2.26	0.3	1.16	0.3	0.64	1.15	1.15	2.94
Eleusineindica (L.) Gaertn.	310	26.45	3.15	12.04	3.15	7.47	11.99	11.99	31.45
Fallopiaconvolvelus	310	5.48	0.61	2.33	0.61	1.55	2.32	2.32	6.18
Guizotiascabra (Vis) Chiov.	310	12.9	0.46	1.76	0.46	3.65	1.75	1.75	7.15
Hygrophillaauriculata(Schm) Heine.	310	10.97	0.6	2.29	0.6	3.1	2.28	2.28	7.66
Lantana camara (L.)	310	6.13	0.38	1.44	0.38	1.73	1.43	1.43	4.6
Leucasmartincensis (Jacq.) Ait. F.	310	5.81	0.18	0.7	0.18	1.64	0.7	0.7	3.04
Nicandraphysalodes (L.) Gaertn.	310	8.71	0.26	1	0.26	2.46	0.99	0.99	4.45
Panicumdichotomiflorum(L).	310	7.1	1.4	5.34	1.4	2.01	5.32	5.32	12.64
Phalarisparadoxa (L).	310	5.48	0.22	0.85	0.22	1.55	0.85	0.85	3.24
Puerariaphaseoloids	310	6.45	0.08	0.31	0.08	1.82	0.31	0.31	2.44
Rottboelliacochinchinensis (Lour.) W. D.	310	11.29	0.84	3.19	0.84	3.19	3.17	3.17	9.54
Stepharniaabysinica(Qu. Dill A. Roch) Walper	310	8.06	0.2	0.75	0.2	2.28	0.75	0.75	3.77
Strigahermontica(Del)Benth	310	4.84	0.26	1	0.26	1.37	0.99	0.99	3.35
Vicia sativa (L).	310	7.1	0.11	0.42	0.11	2.01	0.42	0.42	2.84
Xanthium strumarium (Mill.) Torrey	310	3.87	0.25	0.97	0.25	1.09	0.97	0.97	3.03

Where, TS =Total Sample, F = frequency, A = Abundance, D= Dominance, De = Density, RF= Relative Frequency, RDe= Relative Density, RA= Relative Abundance IVI = Important value index

Moreover, the most frequent weed species recorded which accounted >8% frequency values were: *Commelina benghalensis*, *Commelina diffusa*, *Commelina latifolia*, *Cynodon dactylon*, *Cyperus esculentus*, *Cyperus rotundus*, *Eleusine indica*, *Guizotia scabra*, *Hygrophilla auriculata*, *Nicandra physalodes*, *Rottboellia cochinchinensis* and *Stepharnia abysinica*. The abundant weed species having greater than 1.2 abundance values were *Brachiaria ciliaris*, *Commelina benghalensis*, *Commelina diffusa*, *Commelina latifolia*, *Cyperus rotundus*, *Digitaria abyssinica*, *Eleusine indica and Panicum dichotomiflorum* (Table 3).

Furthermore, the top ten dominant weeds in the plantation estate were: *Brachiaria ciliaris*, *Commelina benghalensis*, *Commelina diffusa*, *Commelina latifolia*, *Cynodon dactylon*, *Cyperus rotundus*, *Digitaria abyssinica*, *Eleusine indica*, *Panicum dichotomiflorum* and *Rottboellia cochinchinensis* which are also the top ten crowdedly found weed species (Table 3). Among these weeds, *Cyperus* species and *Commelina latifolia* were major weed species having a higher dominance level in Wonji-Shoa sugarcane plantation estate irrespective of soil and crop types (Firehun and Tamado, 2007). They also reported *Cyperus* species and *Rottboellia cochinchinensis* as the dominant weed species in Metahara sugarcane plantation. Differences were observed in abundance, frequency and dominance values in this study due to their difference in soil, irrigation technology used, availability of weed seed bank in soil and fertilization, practices.

3.3. Similarity index value of weeds in the plantation estate

According to the description given by Taye and Yohannes (1998), if different crop types/soil types/locations have similar weed community (species composition); they would require similar weed management option. But, if crop or soil types differ in species composition, different kinds of weed control methods are required. Unger (1991) also stated that if the similarity index value is greater than 60%, it is assumed that the two locations, crops types, cane crop types and varieties are similar in species composition and hence the same weed control method can be adopted. However, if the similarity index value is below 60%, it is assumed that the two crops or soil types have different weed communities.

Accordingly, similarity indices of weed community of the study area in different soil types of different crop types and different cane varieties in the fields of the plantation ranged between 6.12 % and 48.39 % (Table 4). Thus, the similarity index values of the weed communities of all strata in both light and heavy soil types lay in much lower than 60%.

Table 4: Similarity index (%) of weed community in different soil types of TanaBeles sugarcane plantation on different crop types and cane varieties

Soil type/crop type and variety		Crop type				
		Sugarcane crop				Soybean crop
		Plant cane		Ratoon cane		
		NCO334	N14	NCO334	N14	
Light Soil						
Plant cane						
	NCO 334	100	30.43	10.91	18.37	27.12
	N14	30.43	100	27.42	28.33	32.35
Ratoon cane						
	NCO 334	10.91	27.42	100	41.18	23.53
	N14	18.37	28.33	41.18	100	22.92
Soybean		27.12	32.35	23.53	22.92	100
Heavy Soil						
Plant cane						
	NCO 334	100	48.39	23.68	6.12	10.71
	N14	48.39	100	17.19	19.4	19.74
Ratoon cane						
	NCO 334	23.68	17.19	100	25	21.62
	N14	6.12	19.4	25	100	28.21
Soybean		10.71	19.74	21.62	28.21	100

In the other case, the similarity index (%) of weed community of different crop types and varieties of different soil types of the plantation fields ranged between 14.29% and 44.68% (Table 5) which is also below 60%.

Table 5: Similarity index (%) of weed community in different crop types and varieties of Tana Beles sugarcane plantation in different soil types

Crop type and varieties/Soil type		Soil type	
		Light soil	Heavy soil
Plant cane			
NCo334			
	Light soil	100	21.05
	Heavy soil	21.05	100
N14			
	Light soil	100	47.37
	Heavy soil	47.37	100
Ratoon cane			
Nco334			
	Light soil	100	14.29
	Heavy soil	14.29	100
N14			
	Light soil	100	25.71
	Heavy soil	25.71	100
Soybean			
	Light soil	100	44.68
	Heavy soil	44.68	100

Generally, the similarity index values of all strata of the study area fall between 6.12% and 48.39%. Hence, the result showed that all the two crop types (sugarcane and soybean), soil types (light and heavy soils), the two sugarcane crop types (plant cane and ratoon cane) and the two sugarcane varieties (NCO334 and N14) have different weed communities viz. SIV< 60%. This leads for adoption of different weed management methods in the plantation site. Weed composition could change depending on some factors during a long period. Planting time and techniques, soil management, harvest time, fertilization, chemical and mechanical weed control methods are the main factors that influence weed incidence (Albrecht, 1995). In this study, the difference of weed communities within the same soil types of the same cane crop types of different cane varieties mainly attributed to the ability of weed hindrance capacity of the N14 as compared to NCO334 (Firehun *et al*., 2013) and the soil weed seed bank.

4. Conclusion

Weeds are constant components of agro-ecosystem that have harmful effect on crop quality and quantity. So, it is a must to have accurate information on the species of weeds, their frequency, uniformity, density, coverage, growth habit and phenology. The study has ranked the most abundant and aggressive weed species in the plantation fields of Tana Beles sugar development project. A total of 148 weed taxa belonging to 31 families were recorded. Among them, 145 weeds were identified at species level while three seedlings were identified at generic level. The plantation is dominated by broadleaf weeds followed by grasses and sedges. Frequency, abundance, dominance and similarity indices constitute substantial criteria of an exact assay of weed infestation. Accordingly, due care should given to properly manage these important weeds.

Moreover, the result shown that all the strata have different weed communities. Therefore, proper designation of weed management strategies that consider each strata independently should be made. it is also recommended that survey and identification of weed flora needs to be done regularly at a certain time interval to identify the flora shift and newly introduced weeds in the plantation estate.

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Appendices

Appendix 1: Weed species found in fields of TanaBeles sugarcane plantation

Family	Species	LC	GH	Weed category
Acanthaceae				
	Hygrophilla auriculata (Schm) Heine.	A	Hs	Broad leaf
Amaranthaceae				
	Amaranthus caudatus (L.)	A	He	Broad leaf
	Amaranthus graecizans (L).	A	He	Broad leaf
	Amaranthus hybridus (L.)	A	He	Broad leaf
	Amaranthus palmeri	A	He	Broad leaf
	Amaranthus retroflexes (L.)	A	He	Broad leaf
	Amaranthus spinosus (L.)	A	He	Broad leaf
	Celosia trigyna (L.)	A	He	Broad leaf
Ayzoaceae				
	Achyranthes aspera (L.)	A	He	Broad leaf
	Trianthema portulacastrum (L.)	A	Hp	Broad leaf
	Trianthema triqueta Willd.	A	He	Broad leaf
Boraginaceae				
	Trichodesma zeylanicum (L.) R. Br.	A	He	Broad leaf
Caesalpiniaceae				
	Caesalpinia decapetala (Roth) Alston	A	He	Broad leaf
Capparidaceae				
	*Cleommono phylla (*L.)	A	He	Broad leaf
Caryophyllaceae				
	Corrigiola litoralis (L.)	P	Hp	Broad leaf
	*Spergula arvensis (*L.)	P	Hp	Broad leaf
Chenopodiaceae				
	*Centrosoma pubsense (*L.)	A	He	Broad leaf
	Chenopodium album (L.)	A	He	Broad leaf
Compositae				
	*Acanthospermum hispidum*DC.	A	Hp	Broad leaf
	Ageratum conyzoides (L.)	A	He	Broad leaf
	Bidens biternata (L.)	A	He	Broad leaf
	Bidens pilosa (L.)	A	He	Broad leaf
	Conyza bonariensis (L.) Cronq.	A	He	Broad leaf
	Cotula abysinica Sch. Bip.ex. A. Rich	A	He	Broad leaf
	Crassoceph alumrubens (Jacq.) S. Moore.	A	He	Broad leaf
	Flaveria trinervia (Spreng.) C. Mohr.	A	He	Broad leaf
	Galinso gaparviflora Cav.	A	He	Broad leaf

	Guizotia abyssinica	A	He	Broad leaf
	Guizotia scabra (Vis) Chiov.	A	He	Broad leaf
	Launae acornuta (Oliv. et Hiern) C. Jeffery.	P	Hr	Broad leaf
	Mikimia macrontha	P	Hv	Broad leaf
	*Selamum indicum (*L.)	A	He	Broad leaf
	Sonchus asper (L.) Hill	A	He	Broad leaf
	*Sonchus exauriculatus (*Olive. &Hiem.)O.Hoffm.	P	He	Broad leaf
	Sonchus oleraceus (L.)	P	He	Broad leaf
	Spilanthes macraei Hook. etArn.	A	He	Broad leaf
	Spilanthes mauritiana (Rich. Ex pers)DC	A	He	Broad leaf
	Tagetes minuta (L.)	A	He	Broad leaf
	Tussilago farafara	A	He	Broad leaf
	Xanthium strumarium (Mill.) Torrey	A	He	Broad leaf
Commelinaceae				
	*Commelina benghalensis (*L.)	A	Hs	Broad leaf
	Commelina diffusa BurmF.	A	Hs	Broad leaf
	Commelina latifolia A. Rich.	A	Hs	Broad leaf
	Commelina subulata Rott.	A	Hs	Broad leaf
Convolvulaceae				
	Convolvulus arvensis (L.)	P	Hc	Broad leaf
	Convolvus spp.	P	Hc	Broad leaf
	Fallopiaconvolvelus	P	Hc	Broad leaf
	*Ipomoea qcquatica*Forssk	P		Broad leaf
	Ipomoea cordofana (Desr.) Choisy	P	Hp	Broad leaf
	*Ipomoea eriocarpa*R. Br.	P	Hp	Broad leaf
	*Ipomoea sinensis*Choisy	P	Hp	Broad leaf
	Stepharnia abysinica (Qu. Dill A. Roch) Walper	P	Hc	Broad leaf
	*Zeneria Scabra (*L.Fil) Sonder	P	Hc	Broad leaf
Cucurbitaceae				
	*Cucurbit apepo (*L.)	A	Hc	Broad leaf
	Langenaria siceraria	A	Hc	Broad leaf
	Momordica charantia	A	Hc	Broad leaf
Cyperaccea				
	*Cyperus assimilis*Steud.	A	T	Sedge
	Cyperus brevifolius	P	R	Sedge
	Cyperus compressus	P	R	Sedge
	Cyperus esculentus (L.)	P	R	Sedge
	*Cyperus rigidifolius*Steud.	P	R	Sedge
	Cyperus rotundus (L.)	P	R	Sedge
	*Cyperus siberianus*Steudel.	P	R	Sedge
	Fimbistyl islitoralis	P	R	Sedge
	Kyllingabulbosa P. Beauv.	P	R	Sedge
Euphorbiaceae				
	Acalyphacrenata A. Rich	A	He	Broad leaf
	Euphorbia helioscopia (L.)	A	H	Broad leaf
	Euphorbia heterophylla (L.)	A	He	Broad leaf
	Euphorbia hirta (L.)	A	Hp	Broad leaf
	Euphorbia indica Lam.	A	He	Broad leaf
	Euphorbia schimperiana Scheele	A	He	Broad leaf
	Ricinuscommunis (L.)L.	P	S	Broad leaf

Fabaceae				
	Acaciaspp.	P	Hs	Broad leaf
	Cassia obtusifolia	P	He	Broad leaf
	Centrosemapubescens	P	H	Broad leaf
	Medicago denticulate	A		Broad leaf
	Medicagopolymorpha (L.)	A	Hp	Broad leaf
	Mililotus alba Medic.	A	He	Broad leaf
	Mimosa invisa (L.)	P	S	Broad leaf
	Mimosa pegra (L.)	P	S	Broad leaf
	Sennaoccidentalis (L.) Link.	A	Hs	Broad leaf
	Sesbaniaspp.	A	He	Broad leaf
	Vicia sativa (L.)	A	Hp	Broad leaf
Gramineae/ Poaceae				
	*Acroptilonrepens (*L.) DC.	A		Grass
	Brachiariaciliaeis	A		Grass
	Brachiariacrusgalli	A		Grass
	Brachiariaeruciformis (J. E. Sm.) Griseb	A	T	Grass
	Brachiariamutica	A		Grass
	Brachiarapaspaloid	A		Grass
	Brachiariareptans(L. Gard and Hubb)	A		Grass
	Cynodondactylon (L.) Pers.	P	R	Grass
	*Cynodonnlemfuensis*Vanderyst.	P	Hp	Grass
	Dactylocteniumaegyptium	P		Grass
	Digitariaabyssinica (A. Rich) Stapf.	A	He	Grass
	Digitariaciliaris (Retz.) Koel	A	T	Grass
	Digitariasanguinalis (L.) Scop.	A	T	Grass
	Digitariascalarum(schweif.) Chiov.	A		Grass
	Dinebraretroflexa (Vahl.) Panzer	A	T	Grass
	Echinochloacolona (L.) Link.	A	T	Grass
	Echinochloa crus-galli (L.) P. B.	A	T	Grass
	Echinochoahaploclada(Stapf) Stapf	A		Grass
	Eleusineindica (L.) Gaertn.	A	T	Grasss
	Eleusinemultiflora	A		Grass
	Eragrostisaspara(Jacq.) Neels.	A		Grass
	Eragrostiscilianensis (All.) Lut.	A	T	Grass
	Ericholafatmensis (Hochst. et Steud.)W. D.	A	T	Grass
	Oplismenuscompositus(L.P) Beav.	P		Grass
	Oplismenushirtellus(L.) P.Beauv.	P		Grass
	Panicumdichotomiflorum(L.)	P		Grass
	Panicumrepens (L.)	P	R	Grass
	Paspalumdistichum	P		Grass
	Paspalumnotatum Fluegge	P	T	Grass
	*Pennisetumclandestinum*Hochst. ExChiov.	P	Hs	Grass
	*Pennisetumglabrum*Steud.	P		Grass
	Pennisetumpolystachion(L.) Schult.	P		Grass
	Phalarisparadoxa (L.)L.	A	T	Grass
	Poaannua(L.)	A		Grass
	Puerariaphaseoloids	P	Hc	Grass
	Rottboelliacochinchinensis (Lour.) W. D.	A	T	Grass

	Setariapumila (Poir.) Roem. etSchult.	A	T	Grasss
	Setariaverticillata (L.) Beauv.	A	T	Grass
	Sorghum arundinaceum (Desv.) Stapf	A	T	Grass
	Sorghum halepense (L.) Pers.	A	T	Grass
Labiatae				
	Leucasmartincensis(Jacq.) Ait. F.	A	He	Broad leaf
Liliaceae			He	Broad leaf
	Allium canadense(L.)	A	He	Broad leaf
	Allium vineale(L.)	A	He	Broad leaf
Malvaceae				
	*Sidaacuta*Burm. F.	P	He	Broad leaf
Plantaginaceae				
	Plantagolancolata (L.)	P	He	Broad leaf
Polygonaceae				
	Oxygonumsinuatum (Meisn.) Dammer	A	Hs	Broad leaf
	*Polygonumnepalensis*Meisn.	A	He	Broad leaf
Portulacaceae				
	Portulacaoleracea (L.)	A	Hp	Broad leaf
Primilaceae				
	Anagallisarvensis (L.)	A	Hs	Broad leaf
Robiaceae				
	Poederiafoetida (L.)L.	P	R	Broad leaf
Scrophulaiaceae				
	Strigaaspera(Wild) Benth.	PAR	H	Broad leaf
	Strigahermontica(Del) Benth.	PAR	H	Broad leaf
Sphenocleaceae				
	*Sphenocleazeylanica*Gaerth	A	Hs	Broad leaf
Spindacea				
	Cardiospermumhelicabum (L.)	A	Hc	Broad leaf
Solanaceae				
	Daturastramonium (L.)	A	He	Broad leaf
	Lycopersiconlycopersicum (L.)	A	He	Broad leaf
	Nicandraphysalodes (L.) Gaertn.	A	He	Broad leaf
	Phaysalis minima (L.)	A	He	Broad leaf
	Solanumcaroliuense	P	T	Broad leaf
	Solanumnigrum (L.)	A	He	Broad leaf
Tiliaceae				
	Corchoruschleocrusgalii(L.)	A	He	Broad leaf
	*Corchoruspseudocapsularis*Schweinf.	A	He	Broad leaf
	Corchorustrilocularis (L.)	A	He	Broad leaf
Verbenaceae				
	Lantana camara (L.)	P	S	Broad leaf

Zygophyllaceae			
Tribulusterrestris (L.)	A	Hp	Broad leaf

Where, A = Annuals, P= Perennials, LC = life cycle, PAR = Parasites,GH = Growth habit, H = Herb, S = Shrub, R = Rhizomatous with vegetative Propagules, T = Tufted, p= prostrate, v= vine, e=erect, c= climber, s= sprawling.

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