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Survey of Weeds in Sesame in the Major Growing Area of Ethiopia

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Abstract: The survey of weeds was conducted in high sesame growing areas of Ethiopia namely, Metekel, Gonder, and Humera Zones during 2018/19 cropping season to assess the abundance and distribution. It was done at the crop seedling stage using a systematic sampling technique and in quadrant counts (0.5 m^2). Weed species composition and their quantitative measures were calculated using descriptive formulas. The result showed 23 weed families that comprised 135 weed species. The most dominant families were Commelinaceae (5.92%), Asteraceae (11%), Cyperaceae (7.40%), Fabaceae (12.59%), and Poaceae (18.51%) respectively. Most of the species (70%) were erect annual herbs and grasses, the rest were perennials that had vegetative propagating structures, annual prostrate herbs, annual, perennial climbers, or perennial shrubs. In the morphological classification, 88 species of broadleaf weeds (65.18%) were found, followed by 33 grasses (24.44%) and 14 (10.37%) types of sedge weeds. Dicotyledonous species were found to be more dominant than monocotyledonous ones in the survey area. The highest weed densities were recorded near the crop harvest stage. Weed species composition varied between crop stages within the same location and across locations at both crop stages. Also, weed composition varied in both crop stages at different locations, indicating a devising different weed management options, which would be considered for different locations in weed flora composition. From this investigation, it can be deduced that Sorghum halepense, Convolvulus arvensis, Amaranthus spp, and Cyperus rotundus turned into a drawback in the sesame production areas.

Keywords: Crops Protection, Weed Species, Weed Densities, Weed Composition, Weed Problems

1. Introduction

Weeds are the most underestimated pest in tropical and sub-tropical agriculture, but they influence human activities more than other crop pests and contribute towards lowering the harvestable yields [1]. Weeds compete with cultivated food crops for limited resources such as water, nutrients, and light [2]. Weed infestation is one of the major factors limiting the yield of sesame, once the cotyledons of sesame emerge, they are small compared to other crops and do not grow fast. Agricultural productivity is geared to a high yield and quality level, but weeds, insect pests and diseases can confront these objectives. Therefore, the protection of crops from these agents is very important. Sesame (Sesamum indicum L; Family Pedaliaceae) is one of the oldest crops known to humans. There are archaeological remnants of sesame dating to 5,500 BC in the Harappa Valley in the Indian subcontinents [3]. It is one of the world's oldest oil seed crop grown mainly for its high oil content that consists approximately 52 - 57% oil and 25% protein [4]. The plant is an erect herbaceous annual with either single stemmed or branched growth habits and has two growth characteristics of indeterminate and determinate, reaching up to 2 m height. It has a large tap root of up to 90 cm [5]. According to Food and Agricultural Organization of the United Nations, 4.8 million metric tons of sesame was produced worldwide in the

year 2016 [6]. India, Japan, and China are the largest exporters. In Africa, Nigeria is the second largest producer after Sudan and ranking seventh in the world [5]. Sesame is mainly cultivated between the 25° N and 25° S latitudes, but it grows in tropical to temperate zones from 40° S to 40° N latitude. Areas with annual rainfall of 625-1100 mm and temperature of >27°C is most conducive for sesame production [3]. The crop is tolerant to drought, but not to water logging and excessive rainfall. It is also productive under high temperature and can grow on residual moisture during the end of a rainy season. This slow development is compounded by the nature of the drought resistance of sesame in that it will decrease large portion of photosynthetic resources to create more root mass to penetrate the soil as quickly as possible to reach moisture. In the first 30 days, sesame plants reach about 28 cm in height and yet will double to 60 cm in 41 days, triple to 90 cm in 49 days, and quadruple to 120 cm in 58 days after emergence (DAE). At this point the sesame plant begins developing canopy. Depending on row spacing and phenotype, mechanization of sesame requires good weed control for 50 to 60 days after planting (DAP) [7]. The survey was conducted with the following objectives:

1) To collect, identify and provide updated information on weed species composition in major sesame production areas of Ethiopia.
2) To determine abundance and distribution of commonly occurring and newly occurring weeds in sesame production of Ethiopia.
3) To prioritize weed problems in sesame growing areas of Ethiopia.

2. Materials and Methods

Weed survey was conducted in sesame growing areas of Ethiopia such as in Pawe, Guba and Dangur districts of Metakel Zone in the Benishangul Gumuz region; Qafta Humera, Welkayit and Tsegade districts of Humera Zone in the Tigray region, and Sanja, Soroqa and Jawi districts in Gonder Zone and Awi Zone in Amhara region. Metekel Zone is located at latitude/longitude 11°19'N and 36° 24'E and altitude of 1120 masl. The average minimum and maximum temperature were 16.3°C and 32.6°C, respectively. The maximum rainfall is 1,587 mm while the length of growing period is 5-7 months in a year. The major soil types are nitosol, veritisol and alluvial soils. Humera Zone is located in western Tigray at longitude and latitude 14°18′N 36°37′E and altitude range of 560-1849 masl. The mean minimum temperature ranges between 17.5°C and 22.2°C, while the mean maximum temperature varies between 33°C and 41.7°C with average annual rain fall that ranges from 400 mm to 650 mm. Gonder Zone is located at altitude that ranges from 12°36N 37°28E with an elevation of 2133 mas. The average temperature ranges from 12°C to 25°C. Mean annual rain fall is 1295 mm. In general, the study area is predominantly categorized as hot and warm sub-moist plain agro ecological zone. The soil texture is mainly salty clay loam slightly alkaline, with a pH range from 7.8 to 8.

2.1. Method of Data Collection

Weed assessment was conducted on both small and large-scale sesame farms at 10 km intervals along the main road. A quadrat of 0.5 m x 0.5 m size was randomly thrown along transects on ten spots per each field, and the weed species type and plant population count were recorded, following the first sample in a quadrat was taken following the procedure of [8]. Where the surveyor walks 50 paces along the edge of the field, then turned right angle and walk 50 paces into the field and sampling started. During the survey all the weeds present in each quadrat were removed, collected, and kept separately species wise in polythene bags for counting. The weeds were separated species wise using the existing experience and available weed identification guidelines, identified and counted [9, 10]. Any plants found in the field that could not be identified on the spot were tagged, pressed, and sent to the national Herbarium of Adds Ababa University. When the plant specimens are completely dry, they were mounted on herbarium sheets and labeled. The species wise classified, weed count data were used to calculate frequency, relative frequency, density, relative density, abundance, dominance, relative uniformity, relative main field density, important value index and similarity index values of the differently located fields.

Mapping of weed species abundance and distribution was made to transfer field observations data records into spatial explicit points on a geographical map. Geographical map indicate where a given weed species' present or absent. In contrast, distribution maps from surveys on field indicate whether a species occurs as a weed in a specific region.

Weed management requires accurate information on weed infestation and distribution within agricultural fields. A geographical positioning system (GPS) latitude and longitude coordinates or the map (Figure 1) were used for survey location sampling points and on field experimental site at Tana Belles in Pawe district, Metekel Zone in Benishangul Gumuz region.

2.2. Method of Data Analysis

The data on weed survey was organized and summarized as frequency (F), abundance (A), dominance (D), important value index (IVI), and similarity index (SI) [10].

1) Frequency (%): is the percentage of sampling plots on which a particular weed species is found in a field. It shows how often a weed species occur in the survey area.

$$\text{Frequency} = \frac{\text{Total number of quadrats in which the species occur}}{\text{Total number of quadrats studied}} \times 100$$

Weed frequency indicates the ratio of the number of fields having specific weed species to the total number of the fields surveyed and is expressed in terms of percentage. It is concerned with the presence or absence of a species in a randomly through quadrat in sesame field**.** It is the percentage of sampling plots of visited field in which a

particular weed species is found.

$$F = X / N * 100 \text{ where,}$$

F = frequency of particular weed specs.

X = number of samples in which a particular weed species found.

N = total numbers of samples in a field.

2) Relative frequency (%): also expressed as a percentage, is the degree of dispersion of individuals (target) species in the sampling unit in relation to the number of all the species occurred.

$$R.F = \frac{\text{Frequency of individuals of a species}}{\text{Total frequency of all species}} \times 100$$

Where, R.F = Relative Frequency

3) Abundance: Population density of a weed species expressed as the number of individuals of weed plants per unit area. A= (∑w)/n where

A = Abundance.

∑w = sum of individual of a particular weed species across all samples.

N = total number of samples in a field.

4) Dominance (%): abundance of an individual weed species in relation to total weed abundance.

$$D = \frac{A \times 100}{\sum A}$$

Where:

D = dominance of a particular species.

A= abundance of the same species.

∑A =total abundance of all weed species

5) Similarity Index: Similarity of weed communities between any two different locations, soil types, surveys, and crop stages in terms of weed composition.

$$SI = \frac{EPg \times 100}{(EPg + Epa + EPb)}$$

Where, SI= similarity index, Epg = number of species found in both locations,

Epa = number of species found only in location a,

Epb = number of species found only in location b.

6) Important Value Index (IVI)

$$IVI = RD + RF + RA$$

Where, IVI = Important Value Index RD= Relative Density

RF = Relative Frequency and RA= Relative Abundance

Quantitative weed measurements i.e., abundance, dominance, frequency, relative density, relative uniformity, and relative main field density were calculated using MS-Excel from the collected data of the survey.

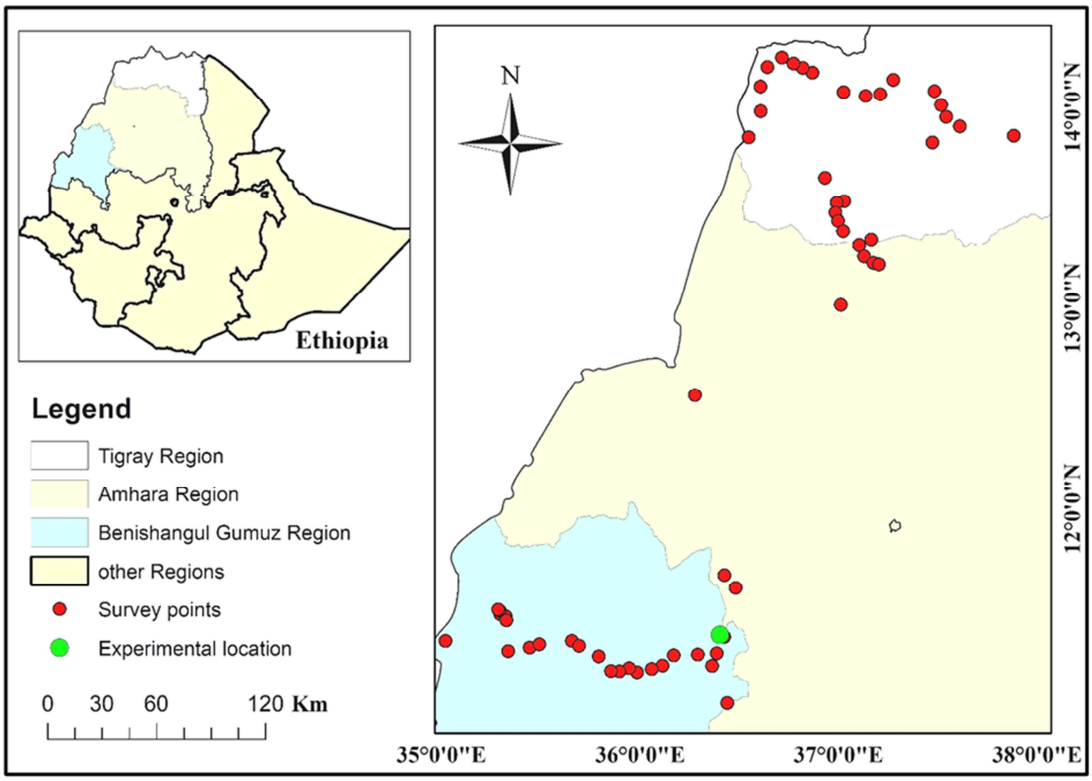

Figure 1. *Map showing surveyed points in Tigray, Amhara and Benishangul Gumuz regional states of Ethiopia.*

3. Results and Discussion

The weed survey was conducted on 60 fields in 46 kebeles of 10 districts, four zones and three regions, and collected and identified 135 weed species. Specimens of any plant encountered in sampling field but couldn't identified on the spot were collected, tagged, and pressed using plant press.

When the plant specimens optimally dry, they were labelled and mounted on herbarium sheets. Most of the weed species except 44 of them were identified on field condition by the team involved on the survey. Out of the 44 weed species, 34 of them were identified by experts at Ambo Agricultural Research Centre and 10 of them were identified at the National Herbarium of Addis Ababa University. These weed species were belong to 23 plant families. The colour of the flower, fruit, fragrance or any special features of the plants collected were documented on the field notebook, The list of weed species under the plant families and their characteristic classes have been presented in Table 1.

Table 1. *List of weed species under the plant families and their characteristic classes.*

No	Name of weed family	Name of species	L C	G H	M G
1	Amaranthaceae	Alternanthera pungens H.	A	Hs	Broad leaf
		Alysicappus quartinian	A	He	Broad leaf
		Amaranthus spinosus L.	A	He	Broad leaf
		Amaranthus viridis L.	A	He	Broad leaf
		Celosia sp.	A	He	Broad leaf
		Achyranthes bidentata Blume	A	He	Broad leaf
2	Brasicaceae	Arabidopsis thaliana (L.)Heynh.	A	He	Broad leaf
		Raphanus raphanistrun L.	A	He	Broad leaf
3	Boraginaceae	Cynoglossum lancelatum Forssk.	A	He	Broad leaf
4	Commelinaceae	Commelina benghalensis L.	A	Hs	Broad leaf
		Commelina diffusa Burm F.	A	Hs	Broad leaf
		Cyanotis axillaris (L.) D. Don ex Sweet	A	Hs	Broad leaf
		Commelina latifolia Hochst A. Rich	A	Hs	Broad leaf
		Cyanotis cristata (L.) D. Don	P	Hs	Broad leaf
		Commelina subulata Roth	A	Hs	Broad leaf
		Cyanotis barbarta D. Don	A	Hs	Broad leaf
		Commelina sp.	A	Hs	Broad leaf
5	Chenopodiaceae	Chenopdium fasciuwlosum	A	He	Broad leaf
		Chamaemelum nobile L.	A	He	Broad leaf
		Chenopdium album L.	A	He	Broad leaf
6	Capparacea	Cleome monophylla L.	A	He	Broad leaf
		Chenopdium procerum (Hachstex)	A	He	Broad leaf
7	Asteraceae	Lactuca serriola L.	P	Hr	Broad leaf
		Ageratum conyzoides L.	P	Hr	Broad leaf
		Sonchus asper (L.) Hill	A	He	Broad leaf
		Sonchus arvensis L.	P	He	Broad leaf
		Spilanthes mauritiana	A	He	Broad leaf
		Tagetus minuta L.	A	He	Broad leaf
		Guzotia scabra (Vis.) Chiov.	A	He	Broad leaf
		Sonchus oleraceus	P	He	Broad leaf
		Bidens pilosa	A	He	Broad leaf
		Galinsoga parvifora	A	He	Broad leaf
		Galinsoga scabra (Vis.) Chiw.	A	He	Broad leaf
		Xanthium sp.	P	He	Broad leaf
		Sonchus asper L.	A	He	Broad leaf
		Vicia auriculata	A	He	Broad leaf
		Xanthium strumarium	A	He	Broad leaf
8	Convoluvulaceae	Convolvulus sp.	P	He	Broadleaf
		Convolvulus arvensis L	P	He	Broadleaf
		Convolvulus mauritanicus	P	He	Broadleaf
		Sedera sp.	P	He	Broadleaf
		Sida alba L.	P	He	Broadleaf
9	Cucurbitaceous	Cuscusta campestris Yuncker	P	He	Broad leaf
		Albuca abyssinica Jacq	P	He	Broad leaf
10	Cyperaceae	Cyperus difformis L.	P	R	Sedge
		Kyllinga bulbosa P. Beauv.	P	R	Sedge
		Morsicus sieceberianus Steudes	P	R	Sedge
		Cyperrus assimilliis Steud	A	T	Sedge
		cyperus escaulentus L.	P	R	Sedge
		Cleome monophylla L	P	R	Sedge
		Cyperus sp.	P	R	Sedge
		Cyperus rotundus L.	P	R	Sedge
		Cyperus haspan L.	P	T	Sedge
		Cyperus triceps L.	P	R	Sedge
11	Euphorbaceae	Euphorbia sp	P	R	Broad leaf
		Ericoloa fatments	P	R	Broad leaf
		Euphorbia hypersifolia L	P	R	Broad leaf

No	Name of weed family	Name of species	L C	G H	M G
		Euphorbia hirta	P	R	Broad leaf
		Brachiaria ciliaeis	A	T	Grass
		Brachiaria crusgalli	A	He	Grass
		Brasisiaceae chiariapaspaloid	A	T	Grass
		Digitaria sanguinalis L.	A	T	Grass
		Digitaria sp	A	T	Grass
		Avena fatua L.	A	T	Grass
		Oplismeus burmnii	A	T	Grass
		Oplismeus hertules	A	T	Grass
		Pennisetium clandestinum	A	T	Grass
		Panicum sp	A	T	Grass
		Pennisetium	A	T	Grass
		Pennistium sp	A	T	Grass
12	Poaceae	Setaria glauca (L.	A	T	Grass
		Setaria verticillata	A	T	Grass
		Setaria viridis (L)	A	T	Grass
		Spilanthes mauritiana	A	T	Grass
		Sorghum halepense (L.)	A	T	Grass
		Stellaria media (L.)	A	T	Grass
		Trachypogon spicatus	A	T	Grass
		Dimbra retroflexa	A	T	Grass
		Dichondra repen	A	T	Grass
		Sorghum sp	A	T	Grass
		Thelepogon	A	T	Grass
		Oplismenus hirtellus	A	T	Grass
		Panicum coloratum	A	T	Grass
		Medicago denticulate	A	Hp	Broad leaf
		Tephrosia purpurea L.	P	He	Broad leaf
		Thelepogon spicatus	P	He	Broad leaf
		Sinapis arvensis L. d	A	He	Broad leaf
		Senna occidentalis (L.) Link	A	S	Broad leaf
		Sanna alata L.	A	S	Broad leaf
		Troubles terrestris L.	A	S	Broad leaf
13	Fabaceae	Trifolium fragiferm L.	P	T	Broad leaf
		Vicia hirsuta (L.)	P	T	Broad leaf
		Alysicappus quartinian	P	T	Broad leaf
		Senna obtusifolia L	A	S	Broad leaf
		Vicoa auriculata Cass.	A	S	Broad leaf
		Vicia sativa L.	P	T	Broad leaf
		Vicia sp	P	T	Broad leaf
		Zornia sp	P	T	Broad leaf
		Vicia hirsute	P	T	Broad leaf
14	Gnopelinaceae	Gnaphalium unions	A	He	Broad leaf
		Galinsoga parvifra	A	He	Broad leaf
		Waltheria indica L	P	He	Broad leaf
		Abutilon hirtum.sweet	P	S	Broad leaf
		Abutilon trisulcatum	P	S	Broad leaf
15	Malvaceae	Abutilon hirtum.sweet	A	He	Broad leaf
		Abutilon trisulcatum	A	He	Broad leaf
		Hibiscus vitifolius	A	He	Broad leaf
		Hibiscus lobatus	A	He	Broad leaf
		Sida sp.	A	He	Broad leaf
16	Nimphaeceae	Water lily	P	He	Broad leaf
		Waltheria indica L	P	He	Broadleaf
		Rumex sp.	A	He	Broad leaf
17	Polygonaceae	Polygonum nepalensis Spre	A	He	Broad leaf
		Polygonum aviculare	A	He	Broad leaf
		Polygonum sp.	A	He	Broad leaf
18	Portulacaceae	Portulaca oleraceus L.	A	He	Broad leaf
		Polygonum barbatum L.	A	He	Broad leaf
		Rumex dentatus L.	A	He	Broad leaf
		Solanum incanum L.	A	He	Broad leaf
		Solidago chilensisL.	A	He	Broad leaf
19	Solanaceae	Datura stramonium L.	A	He	Broad leaf
		Nicandra physaloides	A	He	Broad leaf
		Solanum nigrium	A	He	Broad leaf
		Sporobolus africanus (Poir)	A	He	Broad leaf

No	Name of weed family	Name of species	L C	G H	M G
		Sonchus oleraceus	A	He	Broad leaf
		Nicandra physalodes	A	He	Broad leaf
		Chorchorus alstusumi	A	He	Broad leaf
20	Tiliaceae	Corchorus latiifolia L.	A	He	Broad leaf
		Corchorus olitorius	A	He	Broad leaf
		Chorchorus sp.	A	He	Broad leaf
21	Passifloraceae	Tricliceraspilosum (Wild.) R.	A	He	Broadleaf
22	Typhaceae	Typha latifolia (L.)	A	He	Brad leaf
23	Zygophilaceae	Tribulus terrestris L	P	Hp	Broad leaf
		Tribulus sp	P	Hp	Broad leaf

GH = Growth habit; H = Herb, S = Shrub, R = Rhizomatous with vegetative propagules, T = Tufted, Hp= herb prostrate, He= herb erect.
MG = Morphological group; Broad leaf, Grass, Sedge.

Based on their morphological classification 88 weed species (65.18%) were found broad leaved. followed by 33 grasses (24.44%) and 14 (10.37%) sedges weed types. This result is also in agreement with that of Welday et al. [11] that reported 99 weed species. In their study, (67%) were broad leaved followed by 40 species of grasses (27%) and 9 weed species (6%) of sedges in their weed flora survey. The survey result indicated that dicotyledonous species were more dominant than monocotyledonous ones in the survey area. This might be due to lack of proper cultivation of the fields. Plantations of sesame in the study area were made after one time cultivation followed by furrowing. **T**he result also indicated that the occurrence of weed flora in medium altitude had more weed species diversity as compared to the low altitude areas. However, the weed species diversity in the crop fields within medium altitudes was found similar in most cases.

Table 2. *Weed families, richness, and relative diversity of weeds in sesame field during 2019.*

Order	Family	Reclines	Relative diversity
1	Amaranthuceae	6	4.44
2	Ayzoaceae	1	0..74
3	Brasicaceae	3	2.22
4	Boraginaceae	1	0.74
5	Commelinaceae	8	5.92
6	Capparacea	2	1.48
7	Chenopodacae	3	2.22
8	Asteraceae	15	11.11
9	Convolvulacee	6	4.44
10	Cucurbitaceae	1	0.74
11	Cyperaceae	10	7.40
12	Poaceae	25	18.51
13	Fabaceae	17	12.59
14	Gnopelinaceae	2	1.48
15	Malvaceae	7	5.18
16	Nimphaeceae	2	1.48
17	Polygonaceae	7	5.48
18	Portulacaceae	4	2.96
19	Solanaceae	7	5.18
20	Tiliaceae	4	2.96
21	Passifloraceae	1	0.74
22	Typhaceae	1	0.74
23	Zygophilaceae	2	1.48
Total	23	135	100.

Out of the total 23 plant families recorded in table 2, three dominant families were identified based on the number of tax contained. The plant families that consisted of more than 10 weed species were included: Poaceae (25), Fobaceae (17) and Asteraceae (15). These families constituted of a total 57 weed species of the total 135 weed flora. Therefore, in sesame field the weed species in Poaceae family was found as the most dominant followed by Fobaceae and Asteraceae 15 (Table 1 and Table 2). This might be due to the higher seed bank of these weed species families in the sesame fields.

Weed flora composition in sesame field.

The survey results showed that 51 weed species were recorded in Metekel Zone in Benishangul Gumuz region; 48 weed species in Humera zone in Tigray region, and 36 weed species in Gonder zone in Amhara region.

The occurrence of annuals was higher than perennial weeds which might be due to late weeding at which most of the annual weeds were abundantly grown. In addition, these families are very rich in species diversity, so it is usual that they contain many plant species. Asteraceae, Poaceae, and Fabaceae families were also reported to be economically important and common in different parts of the country [3].

Table 3. *The top ten of frequency, abundance, dominance, and IVI of the weed species in three regions of Ethiopia.*

S/N	Region	Weed Species	F	A	D	RF	IVI
1	Benishangul Gumuz	Convolvulus arvensis L.	14.62	0.638	1.444	3.050	16.702
		Corchorus olitorius L.	14.24	0.747	1.463	0.722	16.45
		Cyanotis spp	13.46	1.685	3.810	2.809	18.955
		Medicago denticulate	46.54	9.323	21.084	9.711	76.947
		Oplismeus hertales	11.54	0.627	1.418	2.408	13.585
		Pennistium spp	11.15	0.404	0.913	2.327	12.467
		Sanna alata L	15.00	0.919	2.079	3.130	18.363
		Sorghum halepense L.	20.77	1.081	2.444	4.334	24.295
		Achyranthes bidentata	12.22	3.004	6.468	15.73	21.692
		Chorchorus olitorius	22.59	1.967	4.235	13.64	28.792
		Commelina latifolia	13.70	0.348	0.750	4.64	14.798
		Cyanotis spp	36.67	16.015	34.487	77.36	87.172
2	Tigray	Cyperus rotundus	14.44	1.815	3.908	11.12	20.163
		Medicago denticulate	16.30	2.256	4.857	13.44	23.413
		Oplismenus burmannii	30.37	3.385	7.290	21.53	41.045
		Panicum spp	17.78	0.456	0.981	6.03	16.217
		Setaria glauca (L.)	20.00	0.778	1.675	7.93	22.453
		Sorghum halepense L.	14.44	0.356	0.766	4.84	15.562
		Vicia sativa L.	32.59	1.244	2.680	12.82	36.514
		Achyranthes bidentata	28.57	1.743	5.677	5.00	35.99
		Cleome monophylla L	11.43	0.314	1.024	2.00	12.768
		Convolvulus arvensis L.	18.57	1.371	4.467	3.25	24.408
		Cyperus assimilliis steudSteud	11.43	1.957	6.375	2.00	19.762
		Cyperus rotundus L	37.14	2.02	6.60	6.50	45.77
		Digitaria sanguinalis L.	35.72	5.17	5.44	6.25	46.33
		Medicago denticulate	57.14	4.14	13.49	10.00	74.77
3	Amahara	Melochia corchorifolia	14.29	0.45	1.48	2.50	16.23
		Oplismenus burmnii	17.14	0.90	2.93	3.00	20.59
		Panicum coloratum	20.00	0.78	2.55	3.50	23.34
		Polygonum hydropower	21.43	0.75	2.46	3.75	24.65
		Sanna alata	21.43	0.51	1.67	3.75	23.61
		Sorghum halepense	11.43	0.28	0.93	2.00	12.64
		Vicia hirsute	18.57	1.05	3.44	3.25	23.07
		Xanthium strumariumL L.	17.14	0.92	3.02	3.00	21.09

NOTE; F = frequency, A= abundance, D= dominancy, RF= relative frequency, IVI= important value Index.

Frequency, Abundance and Dominance of weed species in Sesame.

Out of 135 weed species, and 23 weed families identified in sesame growing area of Ethiopia during 2018 (Figure 2), main cropping season of them were dicotyledons species while 38 species were monocotyledons and 15 species were sedges. Data analysis from the weed survey showed that the most frequent species that were accounted for more than 30% frequency values were: Cyanotis sp (34.67%), Cyperus rotundus (37.14%), Digitaria sanguinalis (35.72%), Medicago denticulata (57.14%), Oplismenus burmannii (30.37%), and Vicia sativa (32.39%) (Tables 3, 4 and 5).

Figure 2. *Pictures depicting data collection on weed species composition and quantitative measures at Qafta Humera in sesame field during the survey in 2018.*

Similarly, the abundant weed species having abundance value greater than five were Cyanotis spp (16.01%), M. denticulate (9.32%), and D. sanguinalis (5.17%). The in mass occurred weed species having higher density value where: Cynotis spp (34.48%) and M. denticulate (21.08%).

Table 4. *Composition, and importance of weed species in sesame field of Metekel Zone, Benishangul Gumuz Region, and Ethiopia.*

Weed species	F	A	D	Rf	IVI
Abutilon hirtum	0.77	0.008	0.017	0.161	0.195
Abutilon trisulcatum	3.46	0.292	0.661	0.722	2.044
Achyranthes bidentate	1.54	0.027	0.061	0.321	0.443
Ageratum conyzides L.	3.85	0.400	0.905	0.803	2.612
Albuca obyssinica	8.85	0.700	1.583	1.846	5.012
Alternanthera pungens H	0.77	0.015	0.035	0.161	0.230
Alysicappus quartinian	0.38	0.046	0.104	0.080	0.289
Amaranthus spinosus L.	5.77	0.200	0.452	1.204	2.108
Amaranthus spp	1.92	0.069	0.157	0.401	0.714
Andrographis paniculata Wall.	0.77	0.023	0.052	0.161	0.265
Andropogon spp	0.38	0.004	0.009	0.080	0.098
Araboidpsis thaliana L. Heynh.	5.00	2.635	5.958	1.043	12.960
Barobarbare	1.15	0.019	0.043	0.241	0.450
Bidens pachyloma (Oliv & Hiern.) cuf.	1.15	0.019	0.043	0.241	0.328
Bidens pilosa L.	5.38	0.235	0.531	1.124	2.185
Chamaemeum nobile L.	1.54	0.069	0.157	0.321	0.634
Chenopdium album L	2.69	0.096	0.217	0.562	0.997
Chenopdium fasciuwlosum	0.38	0.012	0.026	0.080	0.132
Chnopodium procerum	0.77	0.015	0.035	0.161	0.230
Chorchorus alstus	1.15	0.069	0.157	0.241	0.554
Chorchorus olitorius	3.46	0.169	0.383	0.722	1.488
Cleome monophylla L	0.77	0.019	0.043	0.161	0.247
Commelina benghalensis L.	7.69	0.477	1.079	1.605	3.762
Commelina diffusa L.	3.08	0.046	0.104	0.642	0.851
Commelina spp	1.15	0.015	0.035	0.241	0.310
Commelina subulata Rott	0.38	0.035	0.078	0.080	0.237
Commolina latifoliya	6.54	0.446	1.009	1.364	3.382
convolvulus arvensis L.	14.62	0.638	1.444	3.050	5.937
corchorifolia L.	3.08	0.123	0.278	0.642	1.199
Corchorus olitorius L.	6.15	0.285	0.644	1.284	2.571
Cuscusta campestris Yuncker	2.31	0.115	0.261	0.482	1.003
Cyanotis axillaris	3.85	1.123	2.540	0.803	5.882
Cyanotis barbarta D. Don	0.77	0.008	0.017	0.161	0.195
Cynodon dactylon (L.)	1.54	0.069	0.157	0.321	0.634
Cynoglossumlancelatum (Frrsk.)	0.38	0.004	0.009	0.080	0.098
Cynotissp	13.46	1.685	3.810	2.809	10.428
Cyperus rotundus	1.15	0.023	0.052	0.241	0.345
Cyperrus assimilliis steud	0.38	0.012	0.026	0.080	0.132
Cyperus difformis L.	5.00	1.865	4.219	1.043	9.480
cyperus esculentus L.	0.77	0.050	0.113	0.161	0.387
Cyperus rotundus L.	11.54	0.804	1.818	2.408	6.043
Cyperus spp	0.77	0.012	0.026	0.161	0.213
Cyperus tenuispica L.	5.38	0.438	0.992	1.124	3.107
Digitaria sanguinalis	15.00	0.554	1.253	3.130	5.635
Digitaria spp	4.23	0.400	0.905	0.883	2.692
Dimbra retroflexa	0.77	0.127	0.287	0.161	0.735
Ericoloa fatments.	1.54	0.023	0.052	0.321	0.425
Euphorbia hypersifolia L.	3.46	0.292	0.661	0.722	2.044
Galansoga polm	10.00	0.842	1.905	2.087	5.896
Galinsoga parviflora	6.15	0.819	1.853	1.284	4.989
Galinsoga scabra (Vis.) Chiw	1.92	0.138	0.313	0.401	1.028
Galiu spp	8.46	0.342	0.774	1.766	3.314
Gnaphalium unions	1.54	0.031	0.070	0.321	0.460
Guziotia scabar	10.00	2.212	5.001	2.087	12.089
Hibiscus lobatus	1.54	0.027	0.061	0.321	0.443
Hibiscus vitifolius	2.69	0.377	0.852	0.562	2.267
hypersifoliaL	0.38	0.004	0.009	0.080	0.098
Kyllinga bulbosa P. Beauv	1.54	0.035	0.078	0.321	0.478
Lactuca scariola L.	1.92	0.038	0.087	0.401	0.575
Lolium temulentum L.	1.92	0.062	0.139	0.401	0.680

Weed species	F	A	D	Rf	IVI
Medicago denticulate	46.54	9.323	21.084	9.711	51.879
Melochia corchorifolia L.	8.08	0.954	2.157	1.685	6.000
Morsicus sieceberianus steudes	3.08	0.192	0.435	0.642	1.512
Nicandrium physalodes	2.69	0.173	0.391	0.562	1.345
Oplismenus burmannii	5.77	0.096	0.217	1.204	1.639
Oplismeus hertales	11.54	0.627	1.418	2.408	5.243
Panicum coloratum	9.23	1.323	2.992	1.926	7.910
Panicum spp	1.92	0.096	0.217	0.401	0.836
Pennisetium clandestinum	8.08	0.592	1.339	1.685	4.364
Pennistum spp	11.15	0.404	0.913	2.327	4.154
Polygonum aviculare	1.15	0.042	0.096	0.241	0.432
Polygonum barbatum L.	0.38	0.012	0.026	0.080	0.132
Polygonum hydropiper	1.92	0.069	0.157	0.401	0.714
Polygonum nepalensis Spreng.	0.77	0.008	0.017	0.161	0.195
Polygonum spp	3.46	0.462	1.044	0.722	2.810
Portulaca oleraceus L	1.15	0.027	0.061	0.241	0.363
Raphanus raphnistrun L	0.38	0.004	0.009	0.080	0.098
Rumex spp	1.92	0.035	0.078	0.401	0.558
Saana alata L	15.00	0.919	2.079	3.130	7.288
Senna obtusifolia L	0.38	0.023	0.052	0.080	0.185
Senna occidentalis (L.) Link	0.38	0.004	0.009	0.080	0.098
Setaria glauca (L.	7.31	0.273	0.618	1.525	2.760
Setaria vertical	1.15	0.023	0.052	0.241	0.345
Setaria viridis	9.23	0.515	1.166	1.926	4.257
Sida alba L.	0.38	0.004	0.009	0.080	0.098
Sidde pod	7.69	0.565	1.279	1.605	4.162
Sinapis arvensis L. wild mustred	1.92	0.146	0.331	0.401	1.062
Snowdenia polystachea	0.77	0.035	0.078	0.161	0.317
Solanum nigrum L.	1.92	0.046	0.104	0.401	0.610
Solidago chilensisL	2.69	0.227	0.513	0.562	1.588
Sonchus oleraceus	0.38	0.004	0.009	0.080	0.098
Soncus arvensis L.	1.15	0.023	0.052	0.241	0.345
Soncus asper L. Hill	2.69	0.285	0.644	0.562	1.849
Sorghum halepense (L.)	20.77	1.081	2.444	4.334	9.222
Spilanthes mauritiana	3.85	0.219	0.496	0.803	1.794
Sporobolus africanus (Poir)	4.62	0.215	0.487	0.963	1.937
Stellaria media (L.)	4.62	0.623	1.409	0.963	3.781
Tagetus minuta L.	0.77	0.035	0.078	0.161	0.317
Tephrosia purpurea L	1.15	0.062	0.139	0.241	0.519
Thelepogon spicatus	7.69	0.485	1.096	1.605	3.797
Tribulus terrestris L	7.69	0.565	1.279	1.605	4.162
Trifolium fragiferm L	1.54	0.058	0.130	0.321	0.582
Troubles terrestris L.	0.38	0.038	0.087	0.080	0.254
Verba nabracteata	1.54	0.046	0.104	0.321	0.530
Vicia auriculata	0.38	0.015	0.035	0.080	0.150
Vicia hirsuta (L.)	2.31	0.050	0.113	0.482	0.708
Vicia sativa L	10.38	1.962	4.436	2.167	11.039
Vicoaauriculata Cass.	4.62	0.385	0.870	0.963	2.703
Waild cucumber	2.31	0.027	0.061	0.482	0.603
Waltheria indica L	0.38	0.004	0.009	0.080	0.098
Xanthium spp	5.38	0.658	1.487	1.124	4.098
Xanthium strumarium L.	5.77	0.269	0.609	1.204	2.422

Note: F= Frequency; A = Abundance; D = Dominance; Rf = Relative frequency; IVI = Important Value Index

Table 5. *Composition, and importance of weed species in sesame field of Humera zone, Tigray region, Ethiopia.*

Weed species	F	A	D	Rf	IVI
Achyranthes bidentata	12.22	3.004	6.468	2.80	15.73
Albuca obyssinica	0.74	0.007	0.016	0.17	0.20
Alysicappus quartinian	2.59	0.196	0.423	0.59	1.44
Amaranthus spinosus L.	0.37	0.019	0.040	0.08	0.16
Amaranthus viridis	1.85	0.022	0.048	0.42	0.52
Arbagraso	0.74	0.007	0.016	0.17	0.20
Bidens pilosa	0.74	0.007	0.016	0.17	0.20
Calusia spp	1.11	0.030	0.064	0.25	0.38
Chorchorus olitorius	22.59	1.967	4.235	5.17	13.64
Commelina latifolia	0.74	0.044	0.096	0.17	0.36

Weed species	F	A	D	Rf	IVI
Commelina benghalensis L.	5.93	1.133	2.441	1.36	6.24
Commelina diffusa L.	9.26	1.848	3.980	2.12	10.08
Commelina latifolia	13.70	0.348	0.750	3.14	4.64
Commelina spp	4.07	0.067	0.144	0.93	1.22
Convlvulus pluricau	0.74	0.007	0.016	0.17	0.20
Convolvulus arvensis L.	10.37	0.170	0.367	2.37	3.11
Corchorus olitorius	0.37	0.056	0.120	0.08	0.32
Cyanotis cristata	0.37	0.004	0.008	0.08	0.10
Cynotis spp	36.67	16.015	34.487	8.39	77.36
Cyperus difformis L.	4.07	1.289	2.776	0.93	6.48
Cyperus haspan L.	5.93	2.919	6.285	1.36	13.93
Cyperus rotundus	14.44	1.815	3.908	3.31	11.12
Cyperus spp	0.37	0.019	0.040	0.08	0.16
Datura stramonium	0.37	0.004	0.008	0.08	0.10
Dichondrarerepn	1.85	0.037	0.080	0.42	0.58
Digatariae spp	21.11	0.970	2.090	4.83	9.01
Digitaria sanguinalis L.	1.11	0.019	0.040	0.25	0.33
Dimbra retroflexa	0.74	0.007	0.016	0.17	0.20
Ephorbiahartales	2.22	0.119	0.255	0.51	1.02
Ephorbiyahirta	0.74	0.015	0.032	0.17	0.23
Ephorbiya spp	1.11	0.011	0.024	0.25	0.30
Evolvulusnummuerius (L)	0.74	0.011	0.024	0.17	0.22
Galansoga spp	0.74	0.026	0.056	0.17	0.28
Galinsoga parvifra	0.74	0.011	0.024	0.17	0.22
Galium spp	0.37	0.004	0.008	0.08	0.10
Guizotia scabra	5.93	0.115	0.247	1.36	1.85
Hibiscus vitifolius Linn.	0.37	0.011	0.024	0.08	0.13
Hibiscus vitifolius.	0.74	0.019	0.040	0.17	0.25
Kyllinga bulbosa P. Beauv.	2.22	0.074	0.160	0.51	0.83
Lolium temwentum L	0.37	0.004	0.008	0.08	0.10
Medicago denticulate	16.30	2.256	4.857	3.73	13.44
Melochia corchorifolia L.	1.11	0.085	0.183	0.25	0.62
Morsicus sieceberianus steudes	7.04	0.204	0.439	1.61	2.49
Nicandrium	1.11	0.033	0.072	0.25	0.40
Obulismaus	0.74	0.070	0.152	0.17	0.47
Ocimumbenth	0.37	0.004	0.008	0.08	0.10
Oplismenus burmannii	30.37	3.385	7.290	6.95	21.53
Oplismenus hertels	3.33	0.211	0.455	0.76	1.67
Panicom spp	3.70	0.141	0.303	0.85	1.45
Panicum coloratum	4.07	0.159	0.343	0.93	1.62
Panicum spp	17.78	0.456	0.981	4.07	6.03
Phalaris minor	1.85	0.104	0.223	0.42	0.87
Sanna alata L.	7.04	0.259	0.558	1.61	2.73
Senna obtusifolia L	5.19	0.081	0.175	1.19	1.54
Setaria glauca (L.)	20.00	0.778	1.675	4.58	7.93
Setaria viridis (L.)	9.26	0.478	1.029	2.12	4.18
Side pod	6.30	1.267	2.728	1.44	6.90
Solonum nigrium	2.59	0.056	0.120	0.59	0.83
Sonchus solarace	4.44	0.504	1.085	1.02	3.19
Sorghum halepense L.	14.44	0.356	0.766	3.31	4.84
Cyanotis cristata	1.11	0.011	0.024	0.25	0.30
Thelepogon	0.37	0.004	0.008	0.08	0.10
Trachypogon spicatus	2.96	0.030	0.064	0.68	0.81
Tribulus terrestris L.	5.56	0.119	0.255	1.27	1.78
Tribuuis spp	0.74	0.011	0.024	0.17	0.22
Triclicera spoliosum	2.59	0.063	0.136	0.59	0.86
Vicia hirsuta L.	1.85	0.037	0.080	0.42	0.58
Vicia sativa L.	32.59	1.244	2.680	7.46	12.82
Vicoa auriculata	4.81	0.259	0.558	1.10	2.22
Waild Cucumber	0.37	0.004	0.008	0.08	0.10
Watarlili	7.41	0.241	0.518	1.69	2.73
Xanthium strumarium L.	1.48	0.093	0.199	0.34	0.74
Xanthium spp	8.15	0.422	0.909	1.86	3.68

Note: F= Frequency; A = Abundance; D = Dominance; Rf = Relative frequency; IVI Important Value Index

Table 6. *Composition and importance of weed species in sesame fields of Gonder Zone, Amhara Region, Ethiopia.*

Weed species	F	A	D		IVI
Achyranthes bidentata	28.57	1.743	5.677	5.00	16.35
Ageratum conyzoides L.	1.43	0.014	0.047	0.25	0.34
Albuca obyssinica	8.57	0.829	2.699	1.50	6.90
Amaranthus spinout	5.71	1.443	4.700	1.00	10.40
Cleome monophylla L	11.43	0.314	1.024	2.00	4.05
Commelina benghalensis L.	1.43	0.029	0.093	0.25	0.44
Commelina ensiflia	1.43	0.014	0.047	0.25	0.34
Commelina latifolia	8.57	0.286	0.931	1.50	3.36
Commelina spp	4.29	0.400	1.303	0.75	3.36
Commelina subulata Rott	8.57	0.457	1.489	1.50	4.48
Commolina latifoliya	5.71	0.171	0.558	1.00	2.12
Convolvulus arvensis L.	18.57	1.371	4.467	3.25	12.18
Cuscusta campestris Yuncker	1.43	0.043	0.140	0.25	0.53
Cyanotis barbarta D. Don	2.86	0.029	0.093	0.50	0.69
Cynotis spp	4.29	0.271	0.884	0.75	2.52
Cyperus assimilliis steud	11.43	1.957	6.375	2.00	14.75
cyperus escaulentus L.	7.14	0.900	2.932	1.25	7.11
Cyperus rotundus L	37.14	2.029	6.608	6.50	19.72
Cyperus triceps L.	5.71	0.071	0.233	1.00	1.47
Digitaria sanguinalis L.	32.43	1.671	5.444	6.25	17.14
Ericoloa fatments.	5.71	0.171	0.558	1.00	2.12
Euphorbia hypersifolia L.	11.43	0.443	1.443	2.00	4.89
Galinsoga parviflora	5.71	1.114	3.630	1.00	8.26
Galium spp	2.86	0.071	0.233	0.50	0.97
Gozotioa spp	5.71	0.086	0.279	1.00	1.56
Guizotia scabar	4.29	0.043	0.140	0.75	1.03
Kyllinga bulbosa P. Beauv.	10.00	0.957	3.118	1.75	7.99
Lolium temwentum L	1.43	0.014	0.047	0.25	0.34
Medicago denticulate	57.14	4.143	13.495	10.00	36.99
Melochia (Corchorus spp)	5.71	0.071	0.233	1.00	1.47
Melochia corchorifolia L.	14.29	0.457	1.489	2.50	5.48

This study confirmed that these more frequent and dominant weed species are the major social, environmental, and economic threats in the study area.

3.1. Importance Value Index (IVI)

Among the frequent weed families Asteraceae, Poaceae, Cyperaceae and Fabaceae were found the most important in sesame field in Benishangul Gumuz, Tigray and Amhara regions. They were very rich in species combination than other families. [12] reported that weeds belong to the families Asteraceae, Poaceae, and Fabaceae were the most important in arable fields of northern and eastern Ethiopia.

The quantity of weed species from a family does not essentially represent the significance of that family in conditions of aggressiveness. For instance, the top five most important weed species in the sesame field that have scored more than 40 important value indices were Cyanotis sp (87.17), Medicago denticulata (76.94), Digitaria sanguinalis (46.33), Cyperus rotundus (45.77) and Oplismenus burmannii (41.04) (Table 6).

For these grounds, even if Tilaceae family was the most dominant family, its complete species except Cucurbitaceous Turneraceae, and Typhaceae others were not important weeds in the same way. Compositae was the next significant family in the field but there are no such important weed species of this family in their aggressiveness other than Commelinaceae.

This diversity of weed species in fields might show poor weed management, high accumulation of soil weed seed banks, high and frequent precipitation with warm weather conditions, and high fertilization.

In this study, 7 families were most diversified and contributed to about 104 species which is 72.22% of the total flora. The families Asteraceae, Cyperaceae, Commelinacee, Fabaceae, Poaceae and Malvaceae were the richest taxa contributed more than half of the whole flora in the sesame field (Table 2).

In this study Medicago denticulata, Cynotis spp, Cyperus spp and Vicia sativa were found the most diverse weed species within the counters. These species were found as the most dominant species in almost all the surveyed sesame fields in Ethiopia [13].

3.2. Weed Similarity Index

Weed species similarity index between districts of Benishangul Gumuz, Amhara, and Tigray regional states were described following the method used by Taye and Yohannes (1998). Weed communities having similarity indexes > 60% is assumed to be similar in terms of their species composition. Thus, when the weed similarity index is greater than 60%, it is considered that the same control method can be applied. However, if the similarity index is < 60%, on the other hand, it is assumed that the two locations have different weed communities, thus, different control measures should be applied.

The results from this study showed that the highest

similarity index was obtained between Pawe, Soroqa, Sanja, Qafta Humera, Humera, Wolkite, and Tsegade districts from medium altitude, while the lowest similarity was observed between Dangure and Guba, and Dangure and Jawi districts. Therefore, a strategic plan of similar management options can be designed for locations having similarities in species composition. The top-ranking weed species were the most aggressive and difficult weeds to control in different surveyed areas. The high frequency of these weeds showed that they are a serious problem in all agricultural fields.

Table 7. *Weed similarity index among ten districts of Amhara, Benishangul and Tigray regions in Ethiopia during 2018 crop season.*

Location	Dangur	Guba	Pawe	Jawi	Soroqa	Sanja	Humera	Qafta Humra	Welkayit	Tsegade
Dangur	100	45.51	74.14	57.09	68.66	89.72	81.61	85.89	89.77	67.93
Guba		100	83.01	94.49	67.59	90.35	89.96	87.01	87.06	80.76
Pawe			100	68.94	78.04	88.05	80.46	82.01	73.58	86.64
Jawi				100	76.4	77.33	89.84	88.67	70.37	92.74
Soroqa					100	80.55	87.8	83.1	83.22	87.02
Sanja						100	89.56	78.84	63.35	91.25
Humera							100	79.42	78.21	86.15
Qafta Humera								100	77.77	86.26
Wolkite									100	80.95
Tsegade										100

The results showed (table 7), that greater than 60% similarity index were recorded among most surveyed districts from medium altitudes, while the lowest similarity index (<60%) was obtained between Dangur and Guba followed by Dangur and Jawi districts, and with different altitude ranges.

The SI result showed that weed species recorded in Dangur District were considerably different species from the higher altitude areas like Guba and Jawi districts. This result implies that districts with such <60% SI located at different altitudes require different weed management techniques while trying to implement control measures in the crop field. Weed succession and distribution patterns in sesame fields are dynamic in nature and weed flora composition may be region-dependent [13, 14]. Those structures of weed communities and their diversity are determined by environmental and management factors and by interspecific competition between weeds and crop plants and intraspecific competition between plants of the same species. [15-17] stated that there was a broader spectrum of variation and diversity between weeds of sesame from direct seeded areas as compared to transplanted areas. Other studies also depicted that weed flora composition in agricultural systems results from seasonal changes, crop rotation, and long-term environmental changes such as soil erosion and climate change.

4. Conclusion

The weed species composition recorded in sesame in the study areas is found diverse and extensive which demonstrates that weeds are still a significant problem in sesame field. A total of one hundred thirty-five (135) weed species were collected, identified, and characterized from the surveyed 60 sesame fields in the selected 46 kebeles of 10 districts of Metekel, Gonder and Humera Zones. These weed species were distributed in 23 families. The most aggressive and difficult to control weeds have been identified along with their distribution and measures of abundance, dominance, and similarity indices in different locations. Information on weed species composition and their quantitative measures in sesame along with climate, soil, and altitude in each district would be beneficial in designing weed management strategy that would best fit farmers' interest and efficiently control weed problems in sesame.

This survey revealed that Sorghum halepense, Convolvulus arvensis, Amaranthus spp and Cyperus rotundus were becoming a problem of sesame production areas. Weeds which have started increasing over the past few years are now known and a base for future weed surveys has been established. Since the weeds are becoming common and constant constraints of sesame production in the country it is recommended to carry out successive surveys of weeds in all sesame growing areas across the country to have a complete picture of the importance of the weeds across sesame agroecologies.

Author Contribution Statement

All authors listed have significantly contributed to the writing and the development of this article.

Declaration of Competing Interest

All the authors do not have any possible conflicts of interest.

References

[1] Alison R. Gerken, and William R. Morrison. (2022). Pest Management in the Postharvest Agricultural Supply Chain Under Climate Change. https://doi.org/10.3389/fagro.2022.918845. United States Department of Agriculture (USDA).

[2] Akobundu I. O. (1987). Weed Science in the Tropics: Principles and Practices. Wiley Chichester, UK Anonymous (2009). "Purple Witchweed "Infonet-biovisionN. p 14 Sep Web. 7 Dec 2010. http://www.infonetbiovision.org/default/ct/112/pests.

[3] Bedigian D. and J. R. Harlan. 1986. “Evidence for cultivation of sesame in the ancient world,” Economic Botany, vol. 40, no. 2, pp. 137–154.

[4] Gadesa A, Tadesse T, Dabi A (2016) Quantitative Determination of Weed Occurrence on Upland Rice of Bambasi, Ethiopia. Ecology and Evolutionary Biology 1 (3): 53-56.

[5] Umar. Okoye, C. & Mammon, B. 2010 Resource use efficiency in sesame (Sesamum indicum L.) production under organic and inorganic fertilizers applications in Keana Local Government Area, Nasarawa State, Nigeria. Research Journal of Agriculture and Biological Sciences, 6, 466-471.

[6] FAO (2008). Regional sesame production, trade and consumption. United Nation/ Food and Agricultural Organization.

[7] Fiseha B., Tsehaye, Y. & Abay, F. 2015. Grain yield-based yield-based cluster analysis and correlation of agronomic traits of sesame (Sesamum indicum L.) genotypes in Ethiopia. Journal of Natural Sciences Research, 5, 11-17.

[8] Langham, D. (2007). Phonology of sesame. In: Issues in New Crops and New Use.

[9] Langham D R. (2008). Growth and Development of Sesame, Sesaco Corporation.

[10] Stroud Parker C (1989). A Weed Identification Guide for Ethiopia Food and Agriculture Organization of the United Nations Rome, Italy.

[11] Welday Gebreegziabher, Ram S. Verma and Samuel Tegene (2018). Assessment of Critical Period of Weed Competition in Sugarcane (Saccharum spp. Hybrid) at Tana Beles Sugar. Int. J. Adv. Res. Biol. Sci. 5 (6): 91-99, http://dx.doi.org/10.22192/ijarbs.2018.05.06.008.

[12] Assefa Sintayehu (2019). Weed flora survey in field crops of Northwestern. African Journal of Agricultural Research http://dx.doi.10.5897/AJAR2019.13947.

[13] Ethiopia Taye T and T Yohannes. (1998.) Qualitative and quantitative determination of weeds in tef in west Shewa zone. In: Fassi lReda and D. G. Tanner (eds.). Arem 4: 46-60. EWSS, Addis Ababa.

[14] Uddin, M. K., Juraimi, A. S., Ismail, M. R. & Brosnan, J. T. (2010). Characterizing weed populations in different tufgrass sites throughout the klang valley of western Peninsular Malaysia. Weed technology. 24: 173-181.

[15] Tamado T, and Milberg P (2000). Weed Flora in arable fields of Eastern Ethiopia with emphasis on the occurrence of Parthenium hysterophorus. Blackwell Science Ltd Weed Research 40: 507-521.

[16] Firehun, Y. (2004). Weed flora in sugarcane plantations of Wonji-Shoa and Metahara as influenced by some environmental and crop management practices. Msc. Thesis. Alemaya University School of Graduate Studies.

[17] Rao, A. N., Johnson, D. E., Sivaprasad, B. Ladha, J. K., and Mortimer, A. M. (2007): Weed management in direct seeded rice. Advances in Agronomy 93: 153-254.