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Full length Research paper

Quantitative assessment of weeds in Onion fields: in case of central rift valley of Ethiopia.

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Weed population survey were carried out in 200 onion fields of Central Rift Valley of Ethiopia, during 2017/2018 cropping seasons to determine weed species composition, prevalence and distribution. Weed species compositions were determined using a quadrant of 0.5m x 0.5m through systematic sampling technique of inverted W method to obtain representative samples in the field. The individual weed species were analyzed using quantitative means. A total of 43 weed taxa belonging to 16 families were recorded. According to number of species recorded Asteraceae which comprised 16 species, Poaceae10 species, Solonaceae and Cyperaceae 2speciesranks the 1st, 2nd, 3rd abundant weed families respectively. In Adami Tulu woreda: The frequency ranged from 4 to 96%. Argemone Mexicana was the most frequent (96%) and followed by Nicandraphysaloides, Portulacaoleraceae, Cyperusrotundus and Amaranthushybridus. The dominance range in this location was 0.19 to 19% and Portulacaoleraceae, accounted 19.52% of the species which was followed by Cyperusrotundus, Nicandraphysaloides, Amaranthushybridus and Argemone Mexicana. In Dugdaworeda: The frequency of individual weed species ranged from 20 to 96%. Nicandraphysaloides was the most frequent (96%) and followed by Galinsogaparviflora, Amaranthushybridus and Cyperusrotundus. Dominance value ranged from 0.68 to 17.30%. Portulacaoleraceae contribute 17.3% followed by Cyperusrotundus, Chenopodium album, Galinsogaparviflora and Nicandraphysaloides. In Lumeworeda: Portulacaoleraceae was the most frequent (88%) and followed by Galinsogaparviflora, Eleusineindica and Tagetesminuta. The dominance range in this location was 0.17 to 12.08%. Cyperusrotundus account12.08% and followed by Portulacaoleraceae, Commelinabenghalensis, Galinsogaparviflora, Amaranthushybridus and Argemone Mexicana. In around Adama: The frequency range from 6 to 96%. Both Tagetesminuta and Echnochloacolona were the most frequent (96%) and followed by Polygonumnepalense, Galinsogaparviflora, Eleucineindica and Bidenspilosa. Their dominance level ranged from 0.15 to 11.14%. Echinochloacolona accounted 11.14% and followed Bidenspilosa, Tagetesminuta and Amaranthushybridus. Survey of weed flora composition in each location showed some variation infrequency, abundance and dominance of some weed species But in most cases all woradas have similar weed communities (SI>60%). Thus, the frequent, abundant and dominant weeds of all locations and weed flora composition should be considered while devising management strategies.

Keywords: Amaranthushybridus, Argemone Mexicana, Cyperusrotundus, Nicandraphysaloides, Galinsogaparviflora, Portulacaoleraceae

INTRODUCTION

Onion (Allium cepa L) is a recently introduced bulb crop in the agriculture community of Ethiopia and it is produced as a cash crop by small farmers and commercial growers especially under irrigated conditions. Onion is valued for its distinct pungency or mild flavors and form essential ingredients of many dishes in many countries of the world including Ethiopia (Currah and Proctor, 1990). Onion contributed substantially to the national economy, apart from overcoming local demands through exported to different countries of the world (ETFRUIT, 1985-87; EEPA, 2001). This indicates that Ethiopia has high potential to

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benefit from onion crop, with the growing small-scale irrigation scheme in the country.

Appleby *et al*. (2000) reported that the annual worldwide economic loss caused by weeds has been estimated at more than $100 billion U.S. dollars. Weeds are undesirable plants, which infest different crops and inflict negative effect on crop yield either through competition for water or nutrients or space or light (Reddy & Reddi, 2011) and releasing inhibitory chemicals on crop plants (Javaid *et al*., 2007). Weeds are the most yield reducers that are, in many situations, economically more important than insects, fungi or other pest organisms *(*Savary *et al*., 1997*)*. Weeds are one of the pests associated with any agriculture endeavor and compete with onion plants for sunlight, space, water, and nutrients in the soil. Weeds may also act as alternate hosts to insect pests and pathogens attacking onion (Palumbo, 2013*)*. Research conducted by Parker & Fryer, (1975) indicated that, worldwide, over 10% of agricultural production is lost as a result of crop weed competition for the resources light, water and nutrients According to Akobundu (1987) when weeds are left uncontrolled, yield losses range from 20-100%, depending upon the crop and its environment. The author reported loss estimates of 5% in developed countries, 10% in the less developed countries and 25% in the least developed countries.

Onion production is the major activity in different areas of Ethiopia including the Central rift valley region. This crop is grown almost anywhere in between 700 and 1800 m above sea level and under mild climate without extremes of heat or cold and excessive rainfall (Lemma, 2004).

Survey of weed flora and their composition, distribution and intensity is essential for a comprehensive understanding of the weed problem that poses negative impacts on crop production in a given area (Taye & Yohannes, 1998; Uddin *et al.,* 2010).Information on weed density, distribution, and species composition may also help to predict yield losses and such information helps in deciding whether it is economical to control a specific weed problem (Kropff and Spitters, 1991). Weed growth, population density and their distribution are varying from place to place depending upon soil and climatic factors because of it affecting the weed flora and farmers' management practices (Mennan and Isik, 2003).Many authors are reported various broad and grass weed infest onion fields in different countries (Mishra *et al*., 1986; Nadagouda., 1996; Dandge and Satao, 1999; Channappagoudar and Biradar, 2007; Sharma *et al*., 2009; Uygur *et al*., 2010). Therefore, to develop an effective weed management program, a thorough survey is necessary to address the current weed problems in the field. In addition, survey information is entirely important in building target oriented research programs. As far as this, no related study has been conducted regarding the occurrence, distribution, composition and identification of common weeds associated with onion in the Central Rift Valley of Ethiopia. Therefore information generated in this research is important and very useful in predicting the invasive potential of weeds biotypes over time and space and may provide imminent for effective control strategies. Therefore this survey was conducted with the following objectives:

- To assess common weeds associated with onion at a major production areas of Central Rift Valley of Ethiopia and
- To quantify and document the kinds of weed species and its composition

MATERIALS AND METHODS

Description of the study area

The study was conducted in four districts of East Shoa zone of Oromia Regional State, Central Rift Valley (CRV) of Ethiopia (Adami Tulu, Dugda, Lume and around Adama) (Figure 1).The area is known by high potential irrigated vegetable production (Moti. 2002). The area has an arid to semi arid climate with minimum and maximum temperatures of 12.6 ^{0}C and 28.5 ^{0}C respectively. The area is characterized by a bi- modal rainfall pattern ranging from 500 – 850mm with long rainy season extending from June to September (Jansen et al., 2007). The soils are largely volcanic in origin, sandy loam texture with pH ranging from slightly acidic to very alkaline (Jansen *et al*., 2007).

Survey procedures

The survey was carried out in onion fields which were not yet weeded and with area ranging between 1-1.5hectares of land atnearly harvest stage and the harvested field. Onion production requires intensive management and fields were regularly weeded in the study area. Thus, it was difficult to get and identify many weeds. Weeds were sampled using 0.5m^{2}quadrate thrown in systematic way to obtain representative sample in the fields. In each field a pattern of an inverted W (Thomas, 1985) was followed continuously for every 5-7 meters. At each field 7-13 sample quadrats were taken based on field size and species distribution.

The first quadrat sample was taken following the procedure of Kevine *et al*., (1991), where the surveyor walks 50 paces along the edge of the field, turns at right angle and walks 50 paces into the field, throws the quadrant and starts taking sample. Five kebeles were selected from each four woredas purposively based on onion production potential. Ten fields were surveyed in each kebeles. Totally 200 fields were surveyed Weed specimen in the field were identified using weed identification guides (Ciba-Geigy, 1980; Terry & Michieka, 1987; Stroud and Parker, 1989; McIntyre, 1991; Naidu, 2012), literatures(Esayas *et al*., 2012;Terfa, 2018)with help

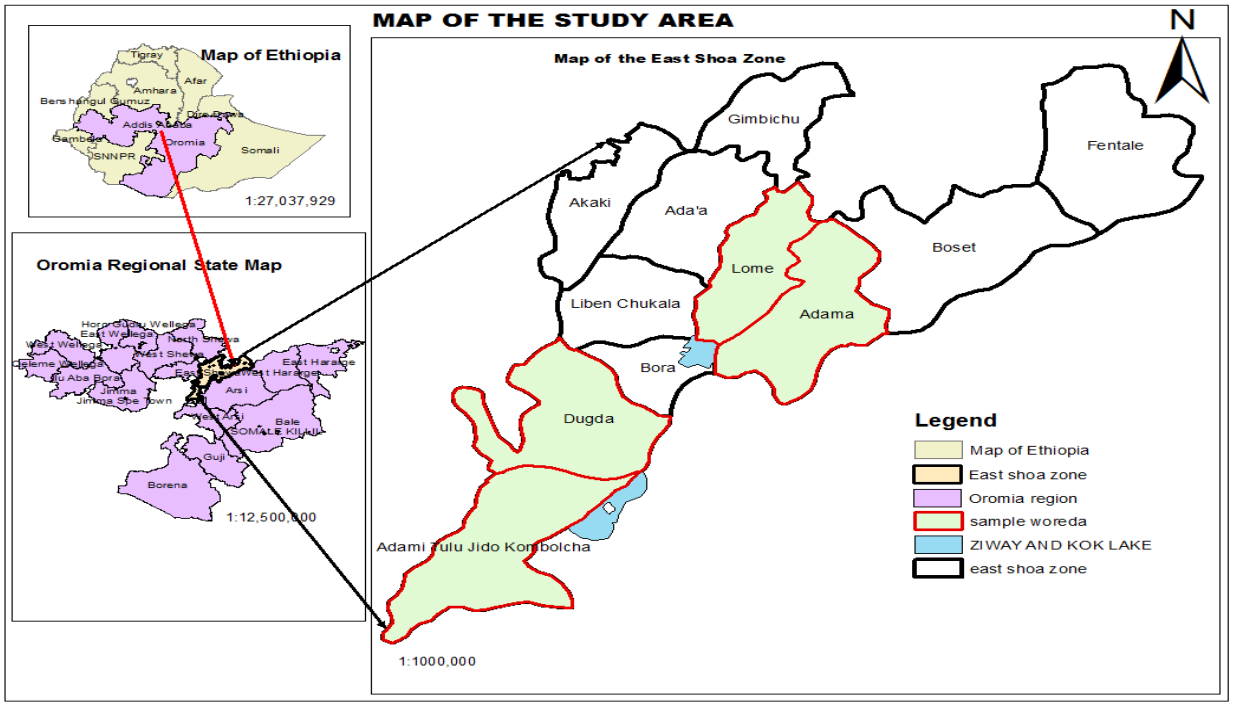

Figure 1: Map of the study areas

of experts. The data on weed species were analyzed using quantitative means formula described by Taye and Yohannis (1998).

Frequency: $F = \frac{X}{N}X100$ ..... (1)

Where, F = frequency, X = number of occurrences of a weed species, N = sample number.

Abundance: $A = \frac{\sum W}{N}$ ..... (2)

Where, A = abundance, W = number of individuals of a weed species, N = sample number.

Dominance: $D = \frac{A}{\sum A}X100$ ..... (3)

Where, D = dominance, ∑A = total abundance of all species.

Similarity index: $SI = \frac{(Epg)}{(Epg + Epa + Epb + Epc + Epd)}X100$ ..... (4)

Where, SI= similarity index; Epg = number of weed species found in all locations (around Adama, Lume, Dugda and AdamiTullu); Epa = number of species only in location a (around Adama); Epb = number of species only in location b (Lume); Epc= number of species only in location c (Dugda); Epd = number of species only in location d (AdamiTullu).

RESULTS AND DISCUSSION

Weed species composition of the study area

Forty three (43) weed species from 16 plant families were recorded (Table 1). Most of the species were erect annual herbs and grasses, the rest were perennials that had vegetative propagules, viz. rhizomes, stolons or tubers, annual prostrate herbs, annual or perennial climbers or perennial shrubs. *Asteraceae* (16 spp.), *Poaceae* (10 spp.), and *Solonaceae* (2 spp.) were the 1st, 2nd, 3rd abundant weed families, respectively (Table1). Pulschen (1990) described that a botanical family is regarded as highly diversified if contains more than five species. Therefore, *Asteraceae* (16spp.) and *Poaceae* (10 spp.) families are the most diverse species of weeds in onion fields of the study area.

As it was reported in results of weed surveys on different crops in other places (Kedir*et al*., 1999 a, b; Taye and Yohannes, 1998) there was a positive and significant relationship among the weed species abundance, dominance and frequency. It was recognized that the dominance level of individual weed species varied across locations and the crop growth stages. Some weed species with high infestation levels at some localities might not occur at similar level and might not be important weeds at other locations. The frequency of occurrence of individual species ranged from 4 to 96, while the infestation level based abundance is ranged from 0.24 to 40.4 whereas based on dominance ranged from 0.15 to 19.52 (Tables 2 - 5). According to Taye and Yohannes (1998), weed species having frequency and dominancy levels below 5.0% and

Table 1: Number of weed families identified and number of species they contain

No-	Family	Number of species
1	Asteraceae	16
2	Poaceae	10
3	Solanaceae	2
4	Cyperaceae	2
5	Amaranthaceae	1
6	Portulaceae	1
7	Chenopodiaceae	1
8	Plantagaceae	1
9	Commelinaceae	1
10	Euphorbaceae	1
11	Convolvolaceae	1
12	Paparavaceae	1
13	Zygophyllaceae	1
14	Brassicaceae	1
15	Pontederiaceae	1
16	Oxalidaceae	1
	Total	43

0.05%, respectively, occur rarely, not significantly distributed and are at low density.

Weed species frequency, Abundance and dominance in Adami Tulu onion- growing areas

Onion fields in Adami Tulu, out of 19 weed species recorded, ten were broadleaved weeds, eight grassy weeds and one sedge. The frequency and infestation levels of individual weed species based on abundance ranged from 4 to 96% and0.4 up to 40.4%, respectively. Dominance value ranged from 0.19 up to 19.52.,*Argemone Mexicana, Nicandraphysaloides, Portulacaoleraceae, Cyperusrotundus Amaranthushybridus, Sonchusarvensis*, *Eleusineindica*, *Echinochloacolona, Daturastramonium, Galinsogaparviflora* and *Chenopodiumalbum* are the most frequent in descending order of their frequency values respectively., *Portulacaoleraceae, Cyperusrotundus, Nicandraphysaloides, Amaranthushybridus, Argemone Mexicana* and *Chenopodium album* are the most abundant and dominant respectively based on their descending order of their abundance and dominance value (Table 2). *Argemone Mexicana* was the most frequent (96%)and dominant weed species contributing to 9.78% of infestation of the onion fields. The most dominant weed species was *Portulacaoleraceae*, contributing up to19.52% of the infestation in the onion fields.

Table:2 Weed species composition, Frequency, Abundance and dominance of delimited areas of Adami Tulu woreda

Botanical name	Family name	Features		Frequency	Abundance	Dominance
Argemone Mexicana	Paparavaceae	d	p	96	14.08	6.80
Nicandraphysaloides	Asteraceae	d	a	90	20.24	9.78
Portulacaoleraceae	Portulaceae	m	p	88	40.4	19.52
Cyperusrotundus	Cyperaceae	m	p	86	32	15.46
Amaranthushybridus	Amaranthaceae	d	a	84	15.52	7.50
Echinochloacolona	Poaceae	m	a	78	7.12	3.44
Sonchusarvensis	Asteraceae	d	p	76	8.8	4.25
Eleusineindica	Poaceae	m	a	70	8.64	4.18
Phalarisparadoxa	Poaceae	m	a	70	8.16	3.94
Daturastramonium	Solanaceae	d	a	68	7.36	3.56
Raphanusraphanistrum	Brassicaceae	d	a	64	7.84	3.79
Plantagolanceolata	Plantaginaceae	d	a	58	7.74	3.74
Chenopodium album	Chenopodaceae	d	a	56	10.24	4.95
Galinsogaparviflora	Asteraceae	d	a	48	7.36	3.56
Agropyronrepen	Poaceae	m	a	42	4	1.93
Digitariaspp	Poaceae	m	a	30	1.92	0.93
Gnaphaliumuliginosum	Asteraceae	d	a	28	3.6	1.74
Senecio vulgaris	Asteraceae	d	p	18	1.52	0.73
Bromuspectinatus	Poaceae	m	a	4	0.4	0.19

Where, m = monocot; d=dicot; a=annual; p=perennial

Weed species frequency, Abundance and dominance in Dugda onion- growing areas

According to the survey results, out of 18 weed species recorded in Dugda, ten were broad leaved weeds, seven grassy weeds and one sedge. The frequency and infestation levels based on abundance of individual weed species ranged from 20 to96% and1.68 up to 31.44%, respectively. Dominance value ranged from0.68 up to 14.88%. Based on frequency Nicandraphysaloides, Amaranthushybridus Galinsogaparviflora, Cyperusrotundus, Polygonumnepalense, Plantagolanceolata and Daturastramonium are the most frequent weed species in descending order of their frequency values respectively. (Table 3). Based on abundance and dominance value, the most abundant and dominant weed species were Portulacaoleraceae, Cyperusrotundus, Chenopodium album, Galinsogaparviflora, Nicandraphysaloides, Amaranthushybridus, Polygonumnepalense and Guizotiascabraare the most in terms of descending order of their abundance and dominance values, respectively. Galinsogaparviflora was the most frequent (96%) and dominant weed species contributing to7.88% of infestation of the onion fields. Portulacaoleraceae contribute up to17.3 % of the infestation in the onion fields.

Table 3: Weed species composition, Frequency, Abundance and dominance of delimited areas of Dugdaworeda

Botanical name	Family name	Features		Frequency	Abundance	Dominance
Nicandraphaseoloides	Solanaceae	d	a	96	14.32	6.78
Galinsogaparviflora	Asteraceae	d	a	92	16.64	7.88
Amaranthushybridus	Amaranthaceae	d	a	88	14.32	6.78
Cyperusrotundus	Cyperaceae	m	p	86	31.44	14.88
Polygonumnepalense	Poaceae	m	a	84	14.16	6.70
Gnaphaliumuliginosum	Poaceae	d	m	82	4.16	1.97
Plantagolanceolata	Plantagnaceae	d	a	80	6.8	3.22
Daturastramonium	Solanaceae	d	a	80	9.12	4.32
Chenopodium album	Chenopodiaceae	d	a	76	22.72	10.75
Eleusineindica	Poaceae	m	a	72	2	0.95
Digitariaischaemum	Poaceae	m	a	70	5.2	2.46
Senecio vulgaris	Asteraceae	d	a	68	1.44	0.68
Bidenspilosa	Asteraceae	d	a	52	10	4.73
Commelinabenghalensis	Commelinaceae	m	a	42	3.36	1.59
Tribulusterrestris	Zygophyllaceae	d	a	42	5.04	2.39
Guizotiascabra	Asteraceae	d	a	34	12.32	5.83
Portulacaoleraceae	Portulaceae	m	p	32	36.56	17.30
Echinochloacolona	Poaceae	m	a	20	1.68	0.80

Where, m = monocot; d=dicot; a=annual; p= Perennial

Weed species frequency, Abundance and dominance in Lume onion- growing areas

According to the survey results, out of 24 weed species recorded in Lume, 12 were broad leaved weeds, eleven grassy weeds and 1sedge. The frequency and infestation levels of individual weed species based on dominance ranged from 4 to 88% and0.17 up to12.08%, respectively. The major weed species found in the area based on their frequency were*, Portulacaoleraceae, Galinsogaparviflora, Eleusineindica, Tagetesminuta, Phalarisparadoxa Daturastramonium, Cyperusrotundus, Amaranthushybridus, Nicandraphysaloides, Argemone Mexicana* and *Commelinabenghalensis*. were the most frequent weed species based on their descending frequency value (Table 4). *Cyperusrotundus, Portulacaoleraceae, Commelinabenghalensis, Galinsogaparviflora, Amaranthushybridus* and *Argemone Mexicana* are the most abundant and dominant weeds in descending order of abundance and dominance value. *Portulacaoleraceae* was the most frequent (88%) and dominant weed species contributing 9.55% of infestation of the onion fields. The most dominant weed species was *Cyperusrotundus*, contributing up to12.08% of the infestation in the onion fields.

Weed species frequency, abundance and dominance in around Adama onion- growing areas

In around Adama, 18 weed species were recorded out of which, ten were broad leaved weeds, eight grassy weeds and one sedge. The frequency of individual weed species ranged from 6 to 96%.Abundance value ranged from 0.32 to 24.64%. Their dominance level ranged from 0.15 to 11.14% In terms of their descending frequency value major weed species were *Tagetesminuta, Echnochloacolona, Polygonumnepalense, Galinsogaparviflora, Eleucineindica. Bidenspilosa, Taraxacumofficinales* and *Chenopodium album* are most frequent ones (Table 5). *Echnochloacolona, Bidenspilosa, Tagetesminuta and*

Table 1: Weed species composition, Frequency, Abundance and dominance of delimited areas of Lumeworeda

Botanical name	Family name	Features		Frequency	Abundance	Dominance
Galinsogaparviflora	Asteraceae	d	a	88	10.16	7.31
Portulacaoleraceae	Portulaceae	m	p	88	13.28	9.55
Phalarisparadoxa	Poaceae	m	a	86	4.96	3.57
Daturastramonium	Poaceae	d	a	86	7.28	5.24
Eleusineindica	Poaceae	m	a	86	9.28	6.67
Cyperusrotundus	Cyperaceae	m	p	82	16.8	12.08
Amaranthushybridus	Amaranthaceae	d	a	80	10.88	7.83
ArgemoneMexicana	Papavaraceae	d	p	76	9.12	6.56
Commelinabenghalensis	Commelinaceae	m	a	76	11.68	8.40
Digitariaischaemum	Poaceae	m	a	76	12.16	8.75
Tagetesminuta	Asteraceae	d	a	72	3.52	2.53
Bidenspilosa	Asteraceae	d	a	60	5.36	3.86
Galiumaparine	Rubiaceae	d	a	46	2.72	1.96
Cynodondactylon	Poaceae	m	p	44	4.64	3.34
Nicandraphaseoloides	Asteraceae	d	a	38	1.76	1.27
Cirsiumarvense	Asteraceae	d	p	38	2.48	1.78
Xanthium strumarium	Asteraceae	d	a	36	4.08	2.93
Lactucaserriola	Asteraceae	m	p	28	1.28	0.92
Echinochloacolona	Poaceae	m	a	26	1.52	1.09
Polygonumnepalense	Poaceae	m	p	26	1.68	1.21
Eichhorniacrassipes	Pontederiaceae	d	p	12	3.28	2.36
Euphorbia hirta	Euphorbiaceae	d	p	6	0.88	0.63
Convulvulusarvensis	Convulvulaceae	d	p	4	0.24	0.17

Where, m = monocot; d=dicot; a=annual; p=Perennial

Amaranthushybridus are the most abundant and dominant weed species in the onion field of the areas in descending order of their abundance and frequency value. The most dominant weed species was *Echinochloacolona*, contributing up to 11.14% of the infestation in the onion fields. *Echinochloacolona and Tagetesminuta* was the most frequent (96%).

Table 2: Weed species composition, Frequency, Abundance and dominance of delimited areas of around Adamaworeda

Botanical name	Family name	Features		Frequency	Abundance	Dominance
Tagetesminuta	Asteraceae	d	a	96	16	7.42
Echinochloacolona	Poaceae	m	a	96	24	11.14
Polygonumnepalense	Poaceae	d	p	88	10.64	4.94
Taraxacumofficinales	Asteraceae	d	p	88	12	5.57
Eleusineindica	Poaceae	m	a	88	14.64	6.79
Galinsogaparviflora	Asteraceae	d	a	88	16.96	7.87
Chenopodium album	Chenopodiaceae	d	a	86	14.8	6.87
Bidenspilosa	Asteraceae	d	a	86	18.4	8.54
Cyperusrotundus	Cyperaceae	m	p	84	11.2	5.20
Plantagolanceolata	Plantaginaceae	d	a	84	13.36	6.20
Oxalis latifolia	Oxalidaceae	d	a	82	13.36	6.20
Amaranthushybridus	Amaranthaceae	d	a	76	16.08	7.46
Chenopodium album	Chenopodiaceae	d	a	60	9.2	4.27
Agropyronrepens	Poaceae	m	p	46	1.84	0.85
ArgemoneMexicana	Paparavaceae	d	p	42	2.64	1.22
Commelinabenghalensis	Commelinaceae	n	a	40	3.12	1.45
Daturastramonium	Solanaceae	d	a	40	3.76	1.74
Senecio vulgaris	Asteraceae	d	p	32	1.92	0.89
Nicandraphaseoloides	Asteraceae	d	a	32	5.44	2.52
Convolvolusarvensis	Convolvulaceae	d	p	30	2.96	1.37
P. hystherophorus	Asteraceae	d	a	8	0.56	0.26
Rumexabyssinicus	Polygonaceae	d	P	8	0.72	0.33
Guizotiascabra	Asteraceae	d	a	6	0.32	0.15
Cynodondactylon	Poaceae	m	p	6	1.6	0.74

Where, m = monocot; d=dicot; a=annual; p=Perennial

Similarity index (SI)

The study showed that in all four study locations similar weed communities were observed (>60%) (Table 6). According to Taye *et al.* (1998) similarity having similar weed community (SI > 60%) will find similar weed management activity.

Table:3 Similarity Index (Percent) of four woredas

Locations	Adami Tulu	Dugda	Lume	around Adama
Adami Tulu	100	90.2	60.3	80.5
Dugda	90.2	100	60.4	80.6
Lume	60.3	60.4	100	90.3
around Adama	80.5	80.6	90.3	100

CONCLUSION AND RECOMMENDATION

The survey identified a large and diversified weed flora. Weed indices showed that four locations have similar weed communities (SI>60%). However, weed flora composition in each location showed some variation in frequency, abundance and dominance of some weed species and the causes for variation might be due to variability of irrigation types and frequencies, previous cropping and crop management system, frequency of cultivation, tillage, weeding and improper use of fertilizers were the major factors. It is important that devising weed management program should be considering the frequent, abundant and dominant weed flora of the area under study. In the future more survey works in different onion production agro-ecologies are recommended to identify the weed species composition and the most important species and monitor population shifts. It is also important to determine the critical weed free period of weed competition, economic threshold levels of major weeds, furthermore, development of economical, environment friendly and sustainable integrated weed management research strategy is crucial for onion production expansion at Central Rift Valley of Ethiopia

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