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Survey of Cotton Weeds in Middle Awash of Ethiopia

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ABSTRACT

Cotton is a widely cultivated fiber crop and plays an important role in the globe. In Ethiopia, cotton is produced in small and large scale, but commercial farms are greatly affected by the problem of weed infestations. Weed survey was done in the potential irrigated cotton growing areas of Middle Awash at seedling and flower initiation stages of the crop. From all locations, the specimen was collected and tagged. Identification of the specimen in the field was done based on weed identification guidelines and those specimens difficult to identify in the field were identified by the national herbarium of Addis Ababa University. Frequency, Abundance, Dominance and Similarity Index were done according to their formula. A total of 27 weed species from 17 families were recorded from all locations. The most dominant weed species are from Poaceae, Amaranthaceae, Euphorbiaceous, Malvacea, Convolvulaceae and Asteraceae weed families in all locations. Weed species composition are different among crop growth stage and similar between districts and across districts and hence, a similar management practice will be applied for the districts.

BACKGROUND

Cotton (*Gossypium hirsutum* L.) is a very important and widely cultivated fiber crop in the world, which is produced for its lint which is the primary commercial product that generates income for cotton producers and fabric for the textile industries (Basra 2002 and MOI, 2015). In Ethiopia, cotton is produced in small and large-scale commercial farms. Suitable arable land for cotton production in the country was estimated at about 3,000,810 hectares (MOA, 2010). Total annual national production was estimated at about 148,649MT raw cotton (EIAR, 2016).

The major cotton growing areas of Ethiopia include the Awash River basin, Northern and Southern Omo, West Gambella, North Bale and Northwest of Metema and Humera. Also the largest potential areas for cotton production were identified in the Western and

Southern parts of the country (MOA, 2010). The major pest problem of cotton production in Ethiopia are lack of effective insect, disease and weed pest management practices(WARC 2000). According to Benedict and Altman (2001) infestation level of any specific pests largely varied from year to year and place to place.

Yield of cotton was greatly reduced due to the natural occurring mixed weed population, which the seed cotton yield loss 62.43 - 96.21% was recorded; when weeding was completely denied throughout the crop growing season (Esayas *et al*., 2013). Losses caused by weeds in Arkansas, USA were estimated 34 million dollars annually (Smith, 2000). Survey conducted in Middle Awash during 2000 cropping season indicated that the infestation level was very high for most of the weed species, thus broad leaf, grass and sedges. Higher weed densities were recorded at flowering and near harvesting growth stage of cotton resulting in reduction of yield and harvest efficiency (WARC 2000). Weed species such as *Xanthium strumarium* that was not economical weeds are critical weeds in cotton fields (Esayas and Abraham, 2000). Similarly a seed cotton yield loss of 35.03-88.13% and 56.45-94.44% occurred when weeding was delayed for 60 and 75 days, respectively. So it could be shown that the major yield loss occurred up to 75 days during the cotton growth period (Esayas *et al*., 2013). Seed cotton yield was increased with the advancement of weed-free period (Esayas *et al*., 2013). On the other hand, the longer weeds were allowed to grow and compete with the crop, the higher the seed cotton yield reduction (Esayas *et al*., 2013). Bishnoi *et al.,* (1993) reported that weed free field from 20 days after sowing produced highest seed cotton yields (2798 kg ha^{-1}) compared to unweeded control (1614 kg ha^{-1}). Khan and Khan (2003) reported that grassy weeds cause 15 – 40% and broad leaf weeds 15 – 30% yield losses in cotton crop. Keeley and Thullen (1991) reported that 16 and 26% of yield losses occurred when Bermuda grass was permitted to compete with cotton for 12 and 20 weeks, respectively. Also yellow nut sedge (*Cyperus esculentus L*.) infestation in cotton field was reduced up to 34% seed cotton yield (Mofett and Mcclosky, 1998).Tillage systems and fertilization determines the composition and abundance of weed species in crop fields and can be helpful in understanding how particular weed species increase or decrease, in terms of numbers and diversity, and how crop management can contribute to the suppression of weeds (Travlos *et al*., 2018)

Weed flora in different locations differ widely in their diversity depending upon environmental and soil conditions and hence the appropriate identification of the weed flora species in the cotton field is essential for the use of effective weed management practices. Therefore, survey of weed flora species composition, distribution and frequency in irrigated Middle Awash potential cotton production areas is essential for a comprehensive understanding of the weed problem that poses negative impacts on cotton production in the study area.

METHODOLOGY

The study was done during 2016 cropping season, between June to September, to determine weed densities, distribution and intensity in irrigated cotton growing areas of middle Awash. The study was carried out in two districts of Middle Awash Rift valley of Ethiopia Amibara (Werer, Badhamo and Melkesedi, Ambash and Billen) and Gewane (Amasabure, Deble, Eglay, Galeallo and Galeallo bora) known by their high potential of irrigated cotton farming. From each irrigated cotton growing districts, 5kebeles and from each kebele, 10-20 farms were randomly selected at every 1-5 Km intervals. The survey was done at seedling and flowering cotton growth stage. The study focuses on small scale farms, private sector and Commercial farms of cotton. During weed sampling, small and large scale areas were considered.

The weed sampling was randomly selected within trisected diagonal in the form of "X" pattern thereby systematically walked in each sample field and the data were counted within $1m^2$ quadrant and a total of 5 samples were taken per hectare.The number of samples per hectare was determined by species in the areas and condition (Pohlan, 1984).Specimens of all weed species encountered in the sampling areas was collected, tagged and pressed in the field using a newspaper and herbarium presser. Field notes were documented by the colour of the flower, fruit, fragrance or any special features of the plants collected. Plant specimens in the field were identified using the available plant identification guides. Identification in the field was based on weed identification guides (Stroud A and Parker C. 1989). Those species that were difficult to identify in the field was tagged, pressed, and sent to the National herbarium of Addis Ababa University and identified.

The data was analyzed by using descriptive statistics to determine weed species composition of abundance (A), dominance (D), frequency (F), and similarity index (SI). The determinations were illustrated by the use of the following formulae (1-4) that was described by Taye and Yohannes (1998).

Frequency: $F = X/N \times 100$…….. (1)

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

Abundance: $A = \sum W/N$…… (2)

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

Dominance: $D = A/\sum A*100$ …… (3)

Where, D = dominance, $\sum A$ = total abundance of all species.

Similarity Index (SI): (Epg)/ (Epg+Epa+Epb)x100 … (4)

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

RESULTS AND DISCUSSION

Weed species composition

A total of 27 weed species within 17 families was recorded in the cotton-growing areas of Middle Awash (Amibara and Gewane) at seedling and flowering stages of cotton growing periods (Tables 1 and 2). From these weed species, 21 were recorded in both locations and weed species only found in Amibara and Gewane were one and six respectively. The prevalence of weed species at cotton seedling stage was higher than that of flowering stage in both locations. In this study the ten most dominant families of the highest diversity according to the represented weed species were *Poaceae, Amaranthaceae, Euphorbiaceous, Malvacea, Convolvulaceae, Asteraceae, Aizoaceae, Cyperaceae, Solanaceae* and *Chenopodiaceae*. Most of the weed species (74 %) were erect annual broad leave herbs, (18.5) grasses, (3.7) Sedges and the rest were annual or perennial climbers or perennial shrubs.

Table 1: Number and proportion of weed species within the seventeen diverse families

No	Family	Life Form	Number of Species	Percent Flora
1	Poaceae	Grass	5	17.85
2	Amaranthaceae	Herb	3	10.74
3	Euphorbiaceae	Herb	3	10.74
4	Malvacea	Herb	2	7.14
5	Convolvulaceae	Herb	2	7.14
6	Asteraceae	Herb	2	7.14
7	Fabaceae	Shrub	1	3.57
8	Cyperaceae	Sedge	1	3.57
9	Cucurbitaceae	Shrub	1	3.57
10	Tiliaceae	Herb	1	3.57
11	Commeliaceae	Herb	1	3.57
12	Solanaceae	Herb	1	3.57
13	Capparaceae	Herb	1	3.57
14	Zygophyllaceae	Herb	1	3.57
15	Chenopodiaceae	Herb	1	3.57
16	Papaveraceae	Herb	1	3.57
17	Aizoaceae	Herb	1	3.57

Frequency and Abundance

The result of weed survey revealed that the dominance level of individual weed species varied across locations and crop growth stages. Asteraceae family has a higher dominance percentage at flowering and lower dominance percentage at seedling in Amibara district and no dominance at Gewane district, while Tiliaceae family has higher dominance percentage at flowering and lower dominance percentage at seedling in Gewane district and lower dominance percentage at Amibara district in both stages

The frequency occurrence of individual weed species ranged from 4 to 80 and 12 to 62 at seedling and flowering stages, while the infestation level based on weed dominance at seedling and flowering cotton stages ranged between 1 to 15, 1 to 37 respectively occurred at high weed density(Tables 1 and 2). This result is supported by Taye and Yohannes (1998), weed species having frequency and dominancy levels below 5.0% and 0.05%, respectively, weeds occurred rarely and at low density. In both Amibara and Gewane districts, higher densities of weed species were recorded during seedling stage. The range of weed species per

sample was higher in both locations Amibara and Gewane during cotton seedling stage. In previous studies on different crops such as field pea, faba bean, barley, wheat and teff, weeds had a positive and significant relationship among the weed species abundance, dominance and frequency (Taye and Yohannes, 1998 and Kedir *et al*., 1999 a b).

The weed flora in cotton fields of Amibara and Gewane were infested by a number of weed species, these weed species infestation of cotton fields can be attributed due to the use of Awash River as irrigation which brings weed seeds and fertile soils from the highland parts of Ethiopia which are required by the crops that create conducive environment for germination and growth of weeds. The average of weed species frequency value over locations, were ranged from 2-80% in both growth stage and districts. The highest weed frequency was recorded by *Digitaria abyssinica* (78%) followed by *Corchorus trilocularis* (74%) and *Eriocloa fatmensis* (72%) at seedling stage in Amibara districts. The lowest frequency value was recorded by *Polypogonmon speliensis* L. (8%) followed by *launaea cornuta,* and *Acalypha crenata* (11 and 12%) respectively. The abundance value of the weed species varied from 1 to 10 plants m-2. The highest abundance value (10 plants m-2) was recorded by *Echinocloa colane* followed by *Digitaria abyssinica* (9 plantsm-2), *Corchorus trilocularis* and *Eriocloa fatmensis* (7 plants m-2). Whereas, the least abundance value (1 plants m-2) was recorded by *Commelina benghalensis* and *Datura stramonium* followed by *Abutilo hirtum*(Lam.), *Ipomea ariocarpa* and *Cucumis dipsaceus (*2 plants m-2) (Table 1). The highest weed frequency value at cotton flowering stage was recorded by (62%) *Digitaria abyssinica* and followed by (60%) *Zaleya pentandra*(L.) and (50%) *Eriocloa fatmensis*. Whereas the least weed frequency was recorded by (10%) *launaea cornuta* and *Cucumis dipsaceus* and followed by (12%) *Amaranthus spinosus* and *Sorghum arundianaceum.* The abundance value ranges from 2 to 38 plants m-2. The highest weed abundance value were recorded by 38 plants m-2 *Xanthium strumarium* and followed by 22 plants m-2 *Cyperus esculentus* and the least abundance value was(1 plant m-2)*Datura stramonium* and (2 plants m-2) *Abutilo hirtum*(Lam.), *Commelina benghalensis* and *Digera muricata*.

The highest frequency value of Gewane location at seedling stage is recorded by *Zaleyapentandra* (L.) (80%) followed by *Echinocloa colane* and *Eriocloa fatmensis* (78%), whereas the least frequency value recorded by *Abutilo hirtum* (Lam.) (4%) and followed by *Argemone mexican* (7%) and *Gynandropsis gynandra* (10%). The weed abundance at seedling stage was varied from 1 to 36 plants m-2. The highest weed abundance value (36 plants m-2) was recorded by *Cyperus esculentus* and followed by 17 plants m-2 *Zaleya pentandra* (L.). The least abundance value was recorded by *Commelina benghalensis* and *Datura stramonium* (1 plant m-2) and followed by *Amaranthus spinosus*, *Abutilo hirtum*(Lam.), *Cucumis dipsaceus* and *Gynandropsis gynandra* (2 plant m-2).

The highest frequency value at flowering stage was (74%) recorded by *Digitaria abyssinica* followed by *Echinocloa colane* (62%) and *Zaleya pentandra* (L.) (60%), whereas, the least frequency level is recorded by *Prosopis juliflora* (6 %). Weed abundance at flowering stage varied from 2 to 41 plants m-2. The highest weed abundance value was recorded by (41%) *Digitaria abyssinica* and followed by *Corchorus trilocularis* (38%) and *Echinocloa colane* (28%), whereas the least weed abundance was recorded by *Ipomea ariocarp* (2%) followed by *Amaranthus spinosus, Convovulus arvensis* and *Sorghum arundianaceum* (4%).

Therefore, this study showed that *Echinocloa colane*, *Eriocloa fatmensis* and *Digitaria abyssinica* weeds has higher frequency and dominance both at seedling and flowering cotton growing stage at Amibara district, whereas *Digitaria abyssinica* and *Zaleya pentandra* (L.) were the highest dominant weed at seedling and flowering cotton growing stage at Gewane district and these weeds are the major environmental and economic problems in the cotton field in the study area. Similar findings were done by (Roger N. *et al* 2015 and Gidesa A. *et al* 2016); they reported that if the specific plant species had higher frequency and dominance value, it indicates the economic importance of it.

Table 2. Amibara Weed Frequency, Abundance and Dominance at Seedling and flowering cotton growing stage in 2016

No	Weed species	Family	Frequency		Abundance		Dominance	
			At Seedling	At Flowering	At Seedling	At Flowering	At Seedling	At Flowering
1	Echinocloa colana	Poaceae	70	40	10	7	11	7
2	Digitaria abyssinica	Poaceae	78	62	9	16	9	15
3	Zaleya pentandra(l.)	Aizoaceae	56	60	4	11	5	10
4	Eriocloa fatmensis	Poaceae	72	50	7	8	9	7
5	Amaranthus spinosus	Amaranthaceae	62	12	5	3	5	1
6	Abutilo hirtum(Lam.)	Malvacea	24	0	2	0	2	0
7	Polypogon monspeliensis(L.)	Poaceae	8	0	2	0	1	0
8	Xanthium strumarium	Asteraceae	48	34	5	38	5	34
9	Convolvulus arvensis	Convolvulaceae	50	20	3	0	3	0
10	Prosopis juliflora	Fabaceae	30	0	2	0	3	0
11	Ipomea ariocarpa	Convolvulaceae	44	16	2	2	2	1
12	Cyperus esculentus	Cyperaceae	60	30	9	22	11	20
13	Launaea cornuta	Asteraceae	11	10	9	2	3	2
14	Cucumis dipsaceus	Cucurbitaceae	34	10	2	2	4	1
15	Sorghum arundianaceum	Poaceae	30	12	2	2	2	2
16	Corchorus trilocularis	Tiliaceae	74	34	7	4	7	4
17	Hibiscus trionum	Malvacea	40	15	4	2	9	1
18	Phyllanthus rotundifolius	Euphorbiaceae	56	0	4	0	4	0
19	Commelina benghalensis	Commeliaceae	26	0	1	0	2	0
20	Digera muricata	Amaranthaceae	38	0	3	0	2	0
21	Acalypha crenata	Euphorbiaceae	12	0	3	0	2	0
22	Datura stramonium	Solanaceae	24	26	1	1	1	1

Table 3. Gewane Weed Frequency, Abundance and Dominance at Seedling and flowering cotton growing stage in 2016

No	Weed species	Family	Frequency		Abundance		Dominance	
			At Seedling	At Flowering	At Seedling	At Flowering	At Seedling	At Flowering
1	Echinocloa colana	Poaceae	78	62	12	28	9	13
2	Digitaria abyssinica	Poaceae	74	74	10	41	7	24
3	Zaleya pentandra(l.)	Aizoaceae	80	60	17	24	13	9
4	Eriocloa fatmensis	Poaceae	78	32	13	7	10	5
5	Amaranthus spinosus	Amaranthaceae	22	26	1	4	2	2
6	Abutilo hirtum(Lam.)	Malvacea	4	0	1	0	1	0
7	Polypogon monspeliensis(L.)	Poaceae	48	0	3	0	2	0
8	Xanthium strumarium	Asteraceae	70	0	6	0	3	0
9	Convolvulus arvensis	Convolvulaceae	36	48	3	4	1	1
10	Prosopis juliflora(Sw.)	Fabaceae	0	6	0	2	0	1
11	Ipomea ariocarpa	Convolvulaceae	58	16	3	2	2	1
12	Cyperus esculentus	Cyperaceae	76	42	36	11	15	4
13	Cucumis dipsaceus	Cucurbitaceae	20	0	1	0	1	0
14	Sorghum arundianaceum	Poaceae	30	24	2	4	1	1
15	Corchorus trilocularis	Tiliaceae	30	56	2	38	2	37
16	Hibiscus trionum	Malvacea	66	0	4	0	1	0
17	Phyllanthus rotundifolius	Euphorbiaceae	68	0	7	0	5	0
18	Commelina benghalensis	Commeliaceae	38	0	2	0	1	0
19	Digera muricata	Amaranthaceae	52	0	5	0	3	0
20	Acalypha crenata	Euphorbiaceae	10	0	1	0	1	0
21	Datura stramonium	Solanaceae	40	58	2	11	2	9
22	Gynandropsis gynandra	Capparaceae	10	0	1	0	1	0
23	Tribulus terrestris	Zygophyllaceae	34	0	7	0	4	0
24	Amaranthus viridisHook.F	Amaranthaceae	42	0	6	0	4	0
25	Chenopodium ambrosiodes	Chenopodiaceae	48	0	3	0	2	0
26	Euphorbia microphylla H.	Euphorbiaceae	10	0	3	0	2	0
27	Argemone mexican	Papaveraceae	7	0	3	0	2	0

Weed Similarity Index

Similarity index is the similarity of plant species composition among different districts. The survey result showed that similarity index value of 71.42% and 68.75% among the districts of Amibara and Gewane at seedling and flowering cotton growing stage respectively (Table 7). This suggests that the weed species composition among the two districts was similar by 71.42% and 68.75%. This result is supported by Taye and Yohannes (1998), if the index of similarity is below 60%, it is said that the two locations have different weed communities. Since similarity indices for the different locations were greater than 60%, it can be concluded that the locations exhibited similar weed community and thus, require similar management options. The similarity index of weed species composition within Amibara districts varied from 78.26 – 90% and 72 – 85.7% at seedling and flowering stages respectively. Likely similarity index of weed species composition at Gewane district varied from 65-86.67% and 61.11-73.33% at seedling and flowering stages. In general the weed species composition in both Amibara and Gewane districts at both cotton growing stages was similar, but the density and frequency of weed species at seedling stage were higher than at flowering stage. The difference in crop stages, altitude, climate, soil types and irrigation type and amount and field management practices applied to the different districts could be the cause that affected the distribution, abundance and dominance of the weed species (Esayas et *al* 2012 and Takim FO and Amodu AA 2013).

Table 4. Similarity Index of Weed species composition of cotton at Seedling stage at Amibara in 2016

	Badhamo	Wadullela	Ambash	Melke-Sedi	Billen
Badhamo	100	81.81	81.81	78.26	75
Wadullela		100	90	85.7	81.81
Ambash			100	85.7	85.7
Melke-sedi				100	78.26
Billen					100

Table 5. Similarity Index of Weeds of cotton at flowering stage at Amibara in 2016

	Badhamo	Wadullela	Ambash	Melke-Sedi	Billen
Badhamo	100	75	78.26	81.81	85.7
Wadullela		100	72	81.81	78.26
Ambash			100	78.26	81.81
Melke-sedi				100	85.7
Billen					100

Table 6. Similarity Index of Weeds of cotton at flowering stage at Gewena in 2016

	Amasabure	Deble	Eglay	Galeallo	Galeallo bora
Amasabure	100	86.67	81.25	86.67	76.47
Deble		100	72.22	76.47	68.42
Eglay			100	72.22	65
Galeallo				100	68.42
Galeallo bora					100

Table 7. Similarity Index of Weeds of cotton at flowering stage at Gewena in 2016

	Amasabure	Deble	Eglay	Galeallo	Galeallo bora
Amasabure	100	73.33	64.7	73.33	64.7
Deble		100	68.75	73.33	64.7
Eglay			100	68.75	61.11
Galeallo				100	74.7
Galeallo bora					100

Table 8. Similarity Index of Weeds of cotton at Amibara and Gewena in 2016

	Seedling Stage	
Survey Sites	Amibara	Gewena
Amibara	100	71.42
Gewena	71.42	100
	Flowering Stage	
Amibara	100	68.75
Gewena	68.75	100

CONCLUSION

Based on the weed survey, a total of twenty seven different weed species from seventeen families were identified. The importance of each weed species was determined by calculating the frequency, abundance and dominance values. This experiment identified a large and diversified weed species that were found in the study area. The most dominant weed families according to the frequency and number of weed species were *Poaceae, Amaranthaceae, Euphorbiaceous, Malvacea, Convolvulaceae* and *Asteraceae*. Weed species composition were similar between districts and across districts. The study shows that the two districts have similar weed species composition and hence, it is possible to apply the same weed management practices for the study areas.

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