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ORIGINAL ARTICLE

Quantitative and Qualitative Determination of Weeds in Cotton-Growing Areas of Humera and Metema, Northwestern Ethiopia

Esayas Tena[1], Abraham G/Hiwet[2] and Mashila Dejene[3]
[1]Sugar Corporation, Research and Training, P.O Box 15, Wonji, Ethiopia,
[2]Werer Agricultural Research Center, EIAR, P.O Box 2003, Addis Ababa, Ethiopia
[3]Haramaya University, P.O Box 138, Dire Dawa, Ethiopia
***Corresponding author:** E-mail: esutena11@gmail.com

ABSTRACT

Weed population surveys were conducted in Metema and Humera cotton-growing areas during the 2009 cropping season to assess the prevalence and distribution of weeds. The survey was done at seedling and near crop harvest stages. Quadrant counts (0.25 m2) were used in a systematic sampling technique to obtain representative samples in the fields. Weed species composition was analyzed using quantitative means and qualitatively identified at the National Herbarium of Addis Ababa University. The most dominant families according to the frequency and number of weed species were *Commelinaceae, Compositeae (Asteraceae), Convolvulaceae, Cyperaceae, Fabaceae, Poaceae, Portulaceae* and *Tilliaceae*. Most of the species (80 %) 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 climber or perennial shrubs. Within the weed spectrum surveyed in both Metema and Humera, dominant weed species were identified at both crop stages. 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 at both crop stages in both places. Thus, when devising a weed control strategy, different weed management options would be considered for the locations differing in weed flora composition.

Keywords: Cotton, qualitative, quantitative, weed species composition, weed flora

INTRODUCTION

There are four domesticated species of the genus Gossipium among which *Gossipium hirsutum* L. is by far the predominant form of cotton grown in the world. Cotton is a multipurpose crop providing more than one single utility. It is source of raw materials for textile industry, cooking oil for human consumption and seed cakes for animal feed. It is also used for manufacturing of various valuable items such as fuel, fertilizers, organic filters, particle boards, high-grade and writing papers (Smith and Cotheren, 1999).

The major cotton growing areas in Ethiopia include the Awash River basin, Arbaminch, Sile, Abaya, Woito and Omorate in the south; Gambella in the west and Metema and Humera in the northwest. Large potential areas also exist in the western, southern and eastern parts of the country. The total area under cotton production is not exactly known, but the area under the former state farms was 42,584 hectares (WARC, 2000). The share of small-scale cotton producers was undetermined and thus no survey works were done to determine the share both in production and area coverage. According to information obtained from USAID Ethiopia (1994), the total area covered by small-scale cotton producers in 1993/94 cropping season was 56, 000 hectares. The major problems of cotton production in Ethiopia include lack of high yielding and widely adaptable varieties, insect pests and diseases, and lack of crop and weed management practices (WARC, 2000).

Weed growth, population density and distribution vary from place to place depending upon soil and climatic factors that affect the weed flora, and farmers' management practices (Saavedra *et al*., 1990). Therefore, survey of weed flora 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. Such assessment of the nature of weed flora determines, to a large extent, the type of weed management measures to be adopted. Taye and Yohannes (1998) reported that weed surveys in Ethiopia in the past were general weed population reconnaissance surveys and collection, which are more qualitative than quantitative in nature. However, a quantitative weed species determination is more informative than the qualitative surveys to fully describe a weed community and establish a basis for devising appropriate weed management strategies.

In cotton-growing areas of Metema and Humera, the problem of weeds is so grave that farmers are disappointed or discouraged to cultivate cotton (personal communication, Metema and Humera Agricultural Bureaus, 2001). The weed species in the areas are very much diversified: broad-leaved weeds, grassy weeds and sedges. Farmers commonly practice hand-weeding and manual cultivation using hand-hoe to suppress weeds in cotton although the traditional weed management method alone is ineffective. The cost of labor for weeding including provision of food is also too high (personal communication, Metema and Humera Agricultural Bureaus, 2001). Some farmers are even forced to shift from growing cotton to cultivation of sesame due to the intense weed problem. To address this problem, first and foremost, the weed species and their composition in the areas should be systematically investigated. Therefore, this survey was conducted to characterize the weed species; determine the prevalence and distribution of the weed flora; and to collect and preserve weed specimens of species from cotton-growing areas of Metema and Humera in northwestern Ethiopia.

METHODOLOGY

Description of the study areas

Metema

Metema is found in northern Ethiopia 900 km northwest of Addis Ababa and about 180 km West of Gondar town. Located in the *Semien* Gondar Zone of the Amhara Region, it has a latitude and longitude of 12°58′ N and 36°12′ E, respectively, with elevations ranging from 550 to 1608 meters above sea level (m.a.s.l). The mean annual temperature and rainfall were 31 ^{o}C and 850 to around 1100 mm, respectively. The natural

vegetation of Metema is predominantly composed of different acacia species with a lot of hyparrhenia grass under grown. Metema is one of the districts, where gum and incense are collected. The soil in the area is predominantly black Vertisol (IPMS, 2005).

Humera

Humera is located in northwestern Ethiopia. Its northern and southern boundaries coincide with $13^0$14′ to $14^0$27′ N latitudes, and $36^0$27′ to $37^0$32′ E longitudes with an average altitude of 568 m.a.s.l. The dominant soil type of the site is chromic black vertisol and characterized by deep (150 cm) clay textured with 40 to 60% clay content, electrical conductivity of 0.047 to 0.17 g mmohs/cm, low organic matter content (<2%), and CEC ranged from 37 to 77 meq/100g of soil (EARO, 2002). The annual rainfall of the area is about 448 mm and the mean annual temperature varies from 25 to 27^0C.

The survey was carried out in 2009 both at the seedling (20-30 days after sowing) and near harvest (120-140 days after sowing) stages of cotton in Metema and Humera cotton-growing areas. In Humera, it was conducted on private cotton farm of Hiwot Mechanization fields namely Kebobo, Weldeab 1-A, Weldeab 1-B, Weldeab-2 and Banat; and in Metema at farmers' holdings in seven locations, namely Aftit, Gendewaha, Gubay, Kokit, Lemlem Terarra, Meka and Worqamba. At Kebobo and Banat in Humera, the survey was conducted during near crop harvest stage only.

Survey Methodology and Data Collection

A quadrant of 0.25 m^2 sampling area was used to sample weed species. In Metema cotton growing sites 5 samples were taken at every 5 km interval in farmers' cotton fields and a total of 30 samples were collected from each district depending on site conditions and the species area curve (Taye and Yohannes, 1998). In the cotton fields of Hiwot Mechanization farm, in each field, a pattern of an inverted W (Thomas 1985) was followed continuously for every 2.5 to 3 hectares. The number of samples per hectare was determined by the species area curve and site conditions (Pohlan, 1984). The first quadrate samples were taken following the procedure of Kevine *et al.* (1991), where the surveyor walks 50 paces along the edge of the field, turns right angle, walks 50 paces into the field, throws quadrant, and starts taking sample. Four fields were surveyed in each stratum. Identification and counting of individual weed species in the quadrants was thoroughly undertaken using the available weed identification guides (Ciba-Geigy, 1980; Terry and Michiek, 1987; Stroud and Parker, 1989; Mc Intyre, 1991). Specimens of weed species that were not identified during the assessment were collected, dried, mounted and identified at the Herbarium of Addis Ababa University Plant Taxonomy Service.

Data analysis

Weed species composition was analyzed by abundance (A), dominance (D), frequency (F), and similarity index (SI) determinations using the formula (1 – 4) described by Taye and Yohannes (1998) as follows.

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

Frequency: $F = X/N \times 100$…… (1)
Where, F = frequency, X = number of occurrences of a weed species, N = sample number.

Abundance: Population density of a weed species expressed as the number of individuals of weed plants per unit area

Abundance: $A = \sum W/N$……... (2)
Where, A = abundance, W = number of individuals of a weed species, N = sample number.

Dominance: Abundance of an individual weed species in relation to the total weed abundance (infestation level).

Dominance: $D = A/\sum A \times 100$…… (3)
Where, D = dominance, $\sum A$ = total abundance of all species.

Similarity index (Community index) is similarity of weed communities among different locations.

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 67 weed species were found in the cotton-growing areas of Metema and Humera at seedling and near harvest stages of cotton (Tables 1 - 4). Out of these weed species, 22 were recorded in Humera and 45 were found in Metema cotton-growing fields. These weed species were distributed in 38 genera within 23 weed families. Pulschen (1990) described that the botanical family regarded as highly diversified, should contain more than five species. In this study the eight most dominant families of the highest diversity according to the represented weed species were *Commelinaceae, Compositeae (Asteraceae), Convolvulaceae, Cyperaceae, Fabaceae, Poaceae, Portulaceae and Tilliaceae*. Most of the species (80 %) 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.

As it was reported in results of weed surveys on different crops in other places, field pea, faba bean, barley, wheat (Kedir *et al*., 1999 a,b) and teff (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 0.32 to 52.3, while the infestation level based on dominance ranged from 0.05 to 76.5 (Tables 1 - 4). According to Taye and Yohannes (1998), weed species having frequency and dominancy levels below 5.0% and 0.05%, respectively, occur rarely and are at low density. In both Meterma and Humera, higher densities of weed species were recorded during near the crop harvest stage. The range of number of weed species per sample was higher in Metema than in Humera. The exception was in Humera where *Dinebra retroflaxa* was highly frequent (45.5%) and dominant (76.5%) at the seedling stage of the crop (Table 3).

Table 1. Weed composition, frequency, abundance and dominance in cotton farms in Metema at seedling stage of the crop

Botanical name	Family	Characteristics	Frequency	Abundance	Dominance
Blumea aurita (L.f) DC.	Asteraceae (Compositeae)	A,H	2.76	0.040	0.67
Boerhaavia erecta	Nyctaginaceae	A,H,E	1.84	0.040	0.67
Brachiaria reptans	Poaceae	A,T	0.92	0.010	0.17
Brachiaria spp.	Poaceae	A,T	1.38	0.020	0.34
Celosia argentea L.	Amaranthaceae	A,E	2.76	0.080	1.35
Cenchrus ciliaris	Poaceae	A,T	19.35	0.520	8.76
Commelina spp.	Commelinaceae	A,P,R	32.30	1.290	21.72
Corchorus spp.	Tilliaceae	A,H,E	11.52	0.280	4.71
Cyperus spp.	Cyperaceae	P,E,R	1.84	0.130	2.19
Dichondra repens	Convolvulaceae	A,H	12.90	0.240	4.04
Echinocloa spp.	Poaceae	A,T	4.60	0.100	1.68
Ethulia gracilis	Asteraceae (Compositeae)	P,H	2.76	0.050	0.84
Ipomea aquatic	Convolvulaceae	A,H,p	0.46	0.005	0.08
Ipomea eriocarpa	Convolvulaceae	A,H,p	10.60	0.180	3.03
Kohautia platyphylla	Rubiaceae	P,R	1.84	0.030	0.51
Launaea cornuta (Hochs)	Asteraceae (Compositeae)	P,H,E	16.59	0.370	6.23
Pennisetum setaceum (Frssk.)chiov)	Poaceae	P,H,S	5.07	0.080	1.35
Phyllanthus pseudonirum	Euphorbiaceae	A,H,E	0.46	0.080	1.35
Physalis ixocarpa Brot.	Solonaceae	A,H	19.35	1.600	26.94
Portulaca spp.	Portulaceae	A,H,p	0.46	0.005	0.08
Rhynchosia malacophylla	Fabaceae	A,H	3.68	0.050	0.84
Senna obtusifolia	Fabaceae	A,H	4.60	0.090	1.52
Sorghum spp.	Poaceae	A,T	0.92	0.090	1.52
Urochloa panicoides	Poaceae	A,T	13.36	0.400	6.74
Xanthium strumarium	Asteraceae (Compositeae)	A,H,E	1.38	0.050	0.84

A=Annual, P=Perennial, T= Tufted, R=Rhizomatous with vegetative propagules, H=Herb, S=Shrub, E=Erect, p=prostrate

Table 2. Weed composition, frequency, abundance and dominance in cotton farms in Metema near harvest stage of the crop

Botanical name	Family	Characteristics	Frequency	Abundance	Dominance
Achyranthes asper	Amaranthaceae	A,H	0.32	0.010	0.17
Alternanthera pungens	Asteraceae (Compositeae)	A,H,E	0.32	0.010	0.17
Blumea aurita	Asteraceae (Compositeae)	A,H	0.64	0.010	0.17
Boerhaavia erecta	Nyctaginaceae	A,H,E	5.12	0.130	2.16
Brachiaria reptans	Poaceae	A,T	7.04	0.160	2.65
Cenchrus ciliaris	Poaceae	A,T	1.60	0.020	0.33
Commelina spp.	Commelinaceae	A,p,R	8.00	0.100	1.66
Corchorus spp.	Tilliaceae	A,H,E	46.40	2.150	35.65
Cyperus spp.	Cyperaceae	P,E,R	8.32	0.160	2.65
Dichondra repens	Convolvulaceae	A,H	16.60	0.320	5.31
Digitaria spp.	Poaceae	A,H,E	4.48	0.040	0.66
Dinebra retroflexa	Poaceae	A,T	23.70	0.370	6.13
Echinocloa spp.	Poaceae	A,T	0.32	0.003	0.05
Eleusine indica	Poaceae	A,T	0.64	0.010	0.17
Ephorbia spp.	Euphorbiaceae	A,H	4.80	0.090	0.15
Eragrosties spp.	Poaceae	A,T	11.84	0.200	3.32
Ericola spp.	Poaceae	A,T	3.50	0.060	0.10
Ethulia gracilis	Asteraceae (Compositeae)	P,H	34.90	0.890	14.76
Hemarthria natans	Poaceae	A,T	1.92	0.020	0.33
Ipomea eriocarpa	Convolvulaceae	A,H,p	8.32	0.120	1.99
Launaea spp.	Asteraceae (Compositeae)	P,H,E	1.28	0.020	0.33
Oldenlandia corymbosa	Rubiaceae	P,R	2.24	0.080	1.33
Pennisetum polystachion (L.)Schult.	Poaceae	P,H,S	0.32	0.003	0.05
Phyllanthus manderaspatensis	Ephorbiaceae	A,H,E	0.32	0.003	0.05
Portulaca oleraceae	Portulacaceae	A,H,p	0.32	0.010	0.17
Pseudarthria hookeri	Fabaceae	A,H	8.32	0.090	1.49
Senna obtusifolia	Fabaceae	A,H	4.16	0.110	1.82
Setaria spp.	Poaceae	A,T	0.32	0.003	0.05
Sida alba	Malvaceae	P,H,E	2.60	0.040	0.07
Solanum spp.	Solanaceae	A,H,E	0.64	0.010	0.17
Sorghum spp	Poaceae	A,T	1.28	0.020	0.33
Sporobolus pyrmindalis	Poaceae	A,T	3.20	0.170	2.82
Straiga spp.	Scrophulariaceae	A,H	0.32	0.003	0.05
Urochloa panicoides	Poaceae	A,T	0.64	0.010	0.17
Zeleya pentandera	Aizoaceae	A,H,p	0.32	0.003	0.05

A=Annual, P=Perennial, T= Tufted, R=Rhizomatous with vegetative propagules, H=Herb, S=Shrub, E=Erect, p=prostrate

Table 3. Weed composition, frequency, abundance and dominance in cotton farms in Humera at seedling stage of the crop

Botanical name	Family	Characteristics	Frequency	Abundance	Dominance
Abelmoschus esculentus	Malvaceae	A,H	5.7	0.06	0.36
Corchorus spp.	Tilliaceae	A,H,E	3.4	0.03	0.18
Cyperus spp.	Cyperaceae	P,E,R	1.1	0.01	0.06
Dichondra repens	Convolvulaceae	A,H	2.3	0.07	0.42
Dinebra retroflexa	Poaceae	A,T	45.5	12.84	76.53
Eragrostis aspera (Jacq.) Nees	Poaceae	A,T	3.4	0.03	0.18
Hermarthria natans Stapf	Poaceae	A,T	3.4	0.03	0.18
Launaea spp.	Asteraceae (Compositeae)	P,H,E	20.5	0.59	3.52
Phyllanthus pseudonirum	Ephorbiaceae	A,H,E	1.1	0.01	0.06
Pseudarthria hookeri	Fabaceae	A,H	52.3	2.77	16.51
Rhynchosia malacophylla	Fabaceae	A,H	2.3	0.02	0.12
Senna obtusifolia	Fabaceae	A,H	9.1	0.11	0.66
Sida alba L.	Poaceae	P,H,E	1.1	0.01	0.06
Snowdenia polystachion	Poaceae	A,T	2.3	0.02	0.12

A=Annual, P=Perennial, T= Tufted, R=Rhizomatous with vegetative propagules, H=Herb, S=Shrub, E=Erect, p=prostrate

Table 4. Weed composition, frequency, abundance and dominance in cotton farms in Humera near harvest stage of the crop

Botanical name	Family	Characteristics	Frequency	Abundance	Dominance
Boerhaavia erecta	Nyctaginaceae	A,H,E	6.34	0.110	2.68
Celosia argentea	Amaranthaceae	A,E	0.70	0.007	0.17
Corchorus spp.	Tilliaceae	A,H,E	40.14	1.880	45.85
Cyperus spp.	Cyperaceae	P,E,R	2.10	0.020	0.49
Dinbera retroflexa	Poaceae	A,T	20.42	0.610	14.88
Ethulia gracilis	Asteraceae (Compositeae)	P,H	3.52	0.040	0.98
Guzatia spp.	Asteraceae (Compositeae)	A,H,E	0.70	0.007	0.17
Hemarthria natans	Poaceae	A,T	0.70	0.007	0.17
Ipomea eriocarpa	Convolvulaceae	A,H,p	3.52	0.030	0.73
Launaea spp.	Asteraceae (Compositeae)	P,H,E	42.25	1.260	30.37
Phyllanthus manderaspatensis	Ephorbiaceae	A,H,E	0.70	0.007	0.17
Pseudarthria hookeri	Fabaceae	A,H	4.23	0.060	1.46
Sorghum spp.	Poaceae	A,T	0.70	0.007	0.17
Straiga spp	Scrophulariaceae	A,H	1.40	0.010	0.24

A=Annual, P=Perennial, T= Tufted, R=Rhizomatous with vegetative propagules, H=Herb, S=Shrub, E=Erect, p=prostrate

Weed species frequency and dominance in Metema cotton-growing areas

According to the survey results, out of 45 weed species recorded in Metema, 30 were broadleaved weeds, 14 grassy weeds and one sedge. The frequency and infestation levels of individual weed species ranged from 0.36 to 46.4% and 0.05 up to 35.65%, respectively. Generally, the major weed species at seedling stage were *Cenchrus ciliaris, Commelina spp*., *Physalis ixocarpa*, *Urochloa panicoides* and *Launaea cornuta* (Table 1). The most dominant weed species was *Physalis ixocarpa*, contributing up to 27% of the infestation in the cotton fields. Near harvest stage of the crop, *Corchorus spp*., *Dichondra repens, Dinebra retroflexa, and Ethulia gracilis* were the major dominant weed species (Table 2). *Corchorus spp*. was the most frequent and dominant weed species contributing to 36% of infestation of the cotton fields.

Gendewaha: Weed species range per sample was highest (67 %) in Metema, particularly in the Gendewaha cotton farm, where 18 broadleaved weeds, 5 grassy weeds and one sedge were recorded near harvest stage of cotton. *Commelina spp.* contributed to 58% of the total weed infestation, followed by *Physalis ixocarpa* (24.6%) at the seedling stage of the crop. *Commelina spp*. was found in all the cotton fields surveyed. During the near harvest stage of the crop *Dinebra retroflexa* was the dominant weed species (14.8 %) but *Corchorus spp.* was the most frequent (42.5 %) of all weed species recorded.

Warqamaba: *Echinocloa colona, Ipomea eriocarpa Echinocloa colona* and *Pennisetum pollystachion* highly infested cotton fields during the seedling stage of the crop. Also, *Ipomea eriocarpa* occupied the larger share with 51% infestation level, while *Dinebra retroflexa* was the most frequent during the near harvest stage of the crop with 48% infestation level.

Gubay: *Commelina spp*., *Eragrostis aspera* and *Physalis ixocarpa* were the most frequent and dominant at seedling stage of the crop, contributing to 28% infestation of the total weed species. Other most frequent weeds included *Dichondra repens*, *Ipomea eriocarpa* and *Senna obtusifolia*, while *Dichondra repens* was the most frequent and dominant weed during near harvest stage of the crop.

Lemlem Terarra: *Eragrostis aspera* and *Physalis ixocarpa* were the most frequent weed species with infestation level of 25 and 33%, respectively at seedling stage of the crop, while *Corchorus spp.* was highly infesting the fields up to 73% during the near harvest stage of the crop. The latter species was also the most frequent (84.8%).

Meka: *Corchorous spp.* was frequent and infesting (18%) the cotton fields at seedling stage, followed by *Eragrostis aspera* (15%) and *Hemarthria natans* (13%). The latter two were also frequent, followed by *Pennisetum setaceum.* Similar to the seedling stage, *Corchorus spp*. was the major weed species representing 35% of the weed infestation, followed by *Ethulia gracilis* during the near harvest stage of the crop.

Aftit: During the seedling stage of the crop, *Commelina spp., Eragrostis aspera, Launaea cornuta,* and *Phylanthus pseudoniruri* were highly infesting the fields. *Commelina spp.* exhibited twice the infestation level of the latter two weeds constituting one-fifth of the total weed *species* in the fields. These weeds were also the most frequent in descending order. *Corchorus spp.* was found most often in the field during the near harvest stage of the crop. This weed also contributed to 47% of the weeds infesting the cotton fields.

Kokit: The infestation level of *Physalis ixocarpa* was double that of *Dichondra repens* and *Launaea coruta* representing almost one-third of the total weed species in the fields during the seedling stage. *Ethulia gracilis* was the most frequent and highly infesting the fields (41%), followed by *Dinebra retroflexa* during the near harvest stage. Other most frequent weed species included *Blumea aurita, Brachiaria reptans, Dichondra repens and Ipomea eriocarpa.*

Weed species frequency and dominance in Humera cotton-growing areas

Among 22 weed species recorded in Humera, 15 were broadleaved and 6 grassy weeds and one sedge (Tables 3 and 4). The frequency and infestation level of individual weed species ranged from 0.7 to 52.3% and 0.12 up to 76.53%, respectively. *Dinebra*

retroflexa, Launaea cornuta and *Pseudarthria hookeri were* dominant at the crop seedling stage, contributing to 97% of the total weed infestation (Table 3). Among the weed species occurred in Humera, *Dinebra retroflexa* contributed up to 77% infestation of cotton fields. Similarly, *Boerhavia erecta, Corchorus spp., Dinebra retroflaxa,* and *Launa cornuta* were the major weeds in the infestation level of cotton fields during near crop harvest stage, (Table 4). *Corchorus spp.* and *Launaea cornuta* contributed to 46 and 30%, respectively, of the total weed infestation.

Weldeab 1-A: *Pseudarthria hookeri* was the most dominant and the most frequent weed species in the area at the seedling stage of cotton, and contributed up to 75% of the total weed infestation, followed by *Dinebra retroflaxa* (18%). At crop harvest stage, *Launaea cornuta* was the most frequent and dominant weed species in the cotton fields with 61% infestation level. Similar to the seedling stage, *Dinebra retroflaxa* was the second frequent (14%) and dominant weed (35%) during near harvest stage of cotton.

Weldeab 1-B: *Dinebra retroflaxa, Launaea cornuta* and *Pseudarthria hookeri,* were dominant at the seedling stage, while *Dinebra retroflaxa*s was the most frequent (47%) weed species. However, *Launaea cornuta* was the most dominant (89%) and frequent weed (73%) during the near harvest stage, contributing to 89% of the total weed infestation.

(3) Weldeab-2: *Pseudarthria hookeri* was the highest in infestation level (43%) and most frequent (40%) at the seedling stage, followed by *Dinebra retroflaxa* and *Launaea cornuta.* However, *Dinebra retroflaxa* contributed to 86% of the total weed infestation during near harvest stage of cotton. This weed species was also the most frequent in the cotton farm.

Similarity index (SI)

Taye and Yohannes (1998) described that weed communities having similarity indices less than 60% among locations and seasons should be considered markedly different and distinct. Accordingly, except for Aftit and Kokit areas in Metema district, weed species composition in cotton fields was dissimilar (SI < 60%) at both crop stages among the surveyed sites both in Humera and Metema (Tables 5 - 8). This is very surprising in that even at different sites of cotton farms found in the same place which are at the same crop growing stage; the weed composition is very different. The difference in altitude, climate, soil types and field management practices applied to the different survey strata could be the cause that affected the distribution, abundance and dominance of the weed species (Pulschen 1990; Jones *et al.,* 1999; Mennan and Isik 2003). Similarly, weed species composition was dissimilar between crop stages among the sites in both places (Tables 9). The weed flora composition at both crop stages was also not similar between Humera and Metema (Table 10). Saavedra *et al.* (1990) noted that weed growth, population density and distribution vary from place to place depending upon soil and climatic factors that affect the weed flora, and farmers' management practices.

Table 5. Similarity index (%) of weed community in different locations in Metema at seedling stage of cotton

Survey sites	Kokit	Gubay	Lemelem Terarra	Werqamba	Meka	Gendewaha	Aftit
Kokit	100.00	21.43	35.48	29.73	21.43	22.58	46.43
Gubay	21.43	100.00	33.33	25.92	42.86	27.78	42.10
Lemelem Terarra	35.48	33.33	100.00	40.00	40.00	40.91	45.83
Werqamba	29.73	25.92	40.00	100.00	25.92	19.35	32.26
Meka	21.43	42.86	40.00	25.92	100.00	42.10	42.1
Gendewuha	22.58	27.78	40.91	19.35	35.29	100.00	38.09
Aftit	46.43	42.10	45.83	32.26	42.10	38.09	100.00

Table 6. Similarity index (%) of weed community at different locations of Metema near harvest stage of cotton

Survey sites	Kokit	Gubay	Lemelem Terarra	Werqamba	Meka	Gendewaha	Aftit
Kokit	100	52	48	17	45	37	71
Gubay	52	100	41	31	26	26	45
Lemelem Terarra	48	41	100	5	22	22	56
Werqamba	17	31	5	100	17	20	13
Meka	45	32	22	17	100	30	24
Gendewuha	37	26	22	20	30	100	30
Aftit	71	45	56	13	24	30	100

Table 7. Similarity of weed community at different cotton farms in Humera at seedling stage of cotton

Survey sites	Woldeab-2	Woldeab 1-A	Woldeab 1-B
Woldeab-2	100.00	28.57	53.85
Woldeab 1-A	28.57	100.00	53.85
Woldeab 1-B	53.85	53.85	100.00

Table 8. Similarity of weed community at different cotton farms in Humera near harvest stage of cotton

Survey sites	Banat	Woldeab 1-A	Woldeab 1-B	Kebebo	Woldeab -2
Banat	100.00	25.00	37.50	25.00	16.70
Woldeab 1-A	25.00	100.00	33.33	18.18	57.14
Woldeab 1-B	37.50	33.33	100.00	18.18	22.22
Kebebo	25.00	18.18	18.18	100.00	14.28
Woldeab -2	16.70	57.14	22.22	14.28	100.00

Table 9. Similarity index (%) of weed community between seedling and harvest stage of the cotton crop in Metema and Humera

Crop stage	Seedling stage	Harvesting stage
	Metema	
Seedling stage	100.00	27.42
Harvesting stage	27.42	100.00
Humera		
Seedling stage	100.00	47.62
Harvesting stage	47.62	100.00

Table 10. Similarity index (%) of weed community between Metema and Humera at seedling and near harvest stage of cotton

Survey sites	**Metema**	**Humera**
	Seedling stage	
Metema	100.00	20.59
Humera	20.59	100.00
	Near harvest stage	
Metema	100.00	25.00
Humera	25.00	100.00

Farmers' practices to control weeds

The majority of cotton-producing farmers in Humera and Metema used hand weeding to control weeds in cotton. In most cases, post-planting weeding operations were carried out using a local long-handled light hoe called "*mewled*". Initial rainfall was very important in Humera and Metema to start pre-planting operations including plowing and disking. After crop emergence, weeding was done using both hand pulling and "*mewled*" starting 10-15 days after crop emergence and continued for 3-5 times weeding depending on the infestation level, pattern of rainfall and availability of labor.

The major problems in Humera and Metema cotton-producing areas found discouraging the farmers to produce cotton were weed infestation, insect pests (flea beetles and boll worms), lack of market for their produce, and poor credit facilities available. Weed species such as *Boerhaavia erecta, Corchorus trilocularis* and *Dinebra retroflexa* (due to their prolific seed production), *Commelina bengalensis* and *Dichondra repens* (due to their stolonous nature), and *Launaea cornuta* (due to

its rhizomatous nature) are found to be noxious which force farmers to incur high cost due to frequent hand weeding. Herbicide use was not practiced in both Humera and Metema cotton fields.

SUMMARY AND CONCLUSIONS

Within the weed spectrum surveyed both in Metema and Humera, dominant weed species were identified at both crop stages. The most dominant families according to the frequency and number of weed species were *Commelinaceae, Compositeae (Asteraceae), Convolvulaceae, Cyperaceae, Fabaceae, Poaceae, Portulaceae and Tilliaceae*. Weed species composition varied between crop stages within the same location and across locations at both crop stages. Thus, when devising a weed control strategy in the future, different weed management options would be required for the locations differing in weed flora composition. Regardless of locations, higher weed density was observed near harvesting stage of cotton, which implies weeding should not be neglected at later stage since higher weed density at this stage has a negative impact on harvest efficiency and lint quality by adding trashes leading to lower price of the lint on the market.

It is also important to determine the economic threshold levels of major weeds in Humera and Metema cotton-producing areas. Further, identifying critical period of weed competition in these potential cotton producing areas is necessity to mobilize the scarce labor available. Facilitating market providing credit and advisory services would encourage the farmers to produce cotton in these high potential cotton-producing areas.

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REFERENCES

Abrham, GH and Esayas, T. 2002. Quantitative and qualitative survey of weeds growing in association with cotton at Middle Awash. Werer Agricultural Research Center (WARC). Progress report for the period 2001/2002. WARC.

Ciba-Geigy. 1980. *Grass weeds 1*. Ciba-Geigy Ltd., Basle, Switzerland.

Esayas, T and Abrham, GH. 2004. Determination of critical period of weed competition and yield and quality loss of cotton at Middle Awash. Werer Agricultural Research Center 2003. Progress report for the period 2003/2004. WARC.

EARO (Ethiopian Agricultural Research Organization). 2002. An assessment of the agricultural production technological package and commercial package and innovation and intervention strategies for commercial farmers in Setit-Humera Wereda of Tigray Regional State. Mekelle. 128p.

IPMS. 2005. Metema pilot learning site diagnosis and program design. ILRI, Addis Ababa, Ethiopia.

Jones E, RS Jessop, B M Sindel and A Hoult. 1999. Utilizing crop residues to control weeds. In: Boersman, AM and CD Barnes (eds.). Proc. of the 12th Aust. Weed Conf. Bishop, Tasamanian Weed Soc., Devonport. pp. 373 – 376

Kedir, N, Feyissa, T and Tilahun, G. 1999a. Results of weed survey in the major barley- and wheat-growing areas of the Bale highlands. Arem 5: 85-95.

Kedir, N, Feyissa, T and Tilahun, G. 1999b. Results of weed survey in the major field pea and faba bean growing-areas of the Bale highlands. Arem. 5: 109-121.

Kevin V, M McCully, G Sampson and A Watson. 1991. Weed survey of Nova Scotia Lawbush Blueberry (Vaccinium angustifolium). Weed Sci. 39:180-18.

McIntyre, G.E. 1991. Weeds of sugarcane in Mauritius: their description and control. Kin Keong Printing Singapore.

Mennan H and D Isik. 2003. Invasive weed species in onion production systems during the last 25years in Amasya, Turkey. Pak. J. Bot. 35 (2): 155 – 160.

Michael, PW. 1982. The role of weed identification in weed management in advancing countries. FAO, Rome.

Pohlan J. 1984. Arable farming 3/4 Weed control. Institute of tropical Agriculture, Plant protection section, Germany.

Pulschen L. 1990. Compositional, synecology and sociological structure of the agrestal flora in Shewa province, Ethiopia. Angew. Botanik 64: 445 – 456

Saavedra, L. Torres, G. Hernan, G. Dez, B. and Hidalgo, B. 1990. Influence of environmental factors on weed flora of field crops. Quvir Valley.

Smith, C.W. and J.T Cotheren. 1999. Cotton: origin, history, technology and production. John Wiley and sons, Inc. New York.

Stroud, A. and Parker, C. 1989. A weed identification guide for Ethiopia. FAO, Rome.

Tadesse, E. 1982. Weed control in irrigated cotton cultivation. In: Proc. of the Symposium on Cotton Production under Irrigation in Ethiopia. Inst. Agric. Res, Ethiopia, 21-22 October, Addis Ababa.

Tadesse, E., and Ahmed, S. 1985. A review of weed research in Ethiopia. In: Proc. of the First Crop Protection Symposium Inst. Agric. Res., Ethiopia, 4-7 February 1985, Addis Ababa.

Taye, T and Yohannes, L. 1998. Qualitative and quantitative determination of weeds in teff in west Shewa Zone. Arem 4: 46-60.

Terry, P.J., and R.W. Michieka. 1987. Common weeds of East Africa/Magugu YaAfrika Mashakari. FAO, Rome.

Thankur, C. 1984. Weed Science. Metropolitan Book Co. Pvt., New Delhi, India.

Thomas AG.1985. Weed survey system used in Saskatchewan for cereals and oilseed crops. Weed Sci. 33:34-43.

USAID Ethiopia, 1994. Cotton sector Assessment. III. Cotton Growing Report.

Werer Agricultural Resaerch Center (WARC). 2000. Strategies and priorities for cotton research.