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Research Article

Weed Prevalence, Distribution and Abundance in Wheat Growing Areas of North Gondar, Northwestern Ethiopia

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Abstract

A field survey was conducted to identify weed species and to quantify weed prevalence, abundance and diversity as well as its distribution in North Gondar, Ethiopia in four major wheat producing areas such as Debark, Dabat, Wegera and Gondar zuria district during 2017 and 2018 cropping season. Three major wheat producing kebeles were selected in each district and from four districts, a total of 120 wheat producing farmers' fields were assessed. The study areas have some variations regarding altitude, annual mean temperature, rain fall, soil characteristics, cropping pattern, weed management strategy etc. Despite to these factors, some weed species frequently occurred in all wheat farms of the study areas. A total of 17 major weed species were identified out of which 7 (41.2%) were grass weeds and 10 (58.8%) were broad-leaved weeds in total species-wise composition. The most prevailed weed species in all wheat farms of study areas were *Polygonium nepalense, Hypochoeris radicata, Galinsoga parviflora, Avena fatua, Gallium spurium,* and *Medicago polymorpha*. Some weed species were limited in its occurrence; *Spergula arvensis* and *Guizotia scabra* was prevailed in Dabat and Gondar zuria wheat farms but not Wogera and Debark districts. In the contrary *Medicago polymorpha, Hyparrhenia rufa (Nees)* and *Eleusine indica* weed species were frequently occurred and highly distributed in Wegera and Debark district wheat farms but not in mid-altitude of Dabat and Gondar zuria districts. However, *Oxalis latifola* weed species was found only Gondar zuria districts. The finding indicates that proper weed management is interventions that can reduce the impact of wheat yield losses in Ethiopia. Therefore, integrated weed management options should be implemented for the future for those major weeds of wheat.

Keywords: Abundance, altitude, density, districts, diversity, prevalence, weed species.

Introduction

Wheat belongs to the family *Pocaceae* and the genus *Triticum*. It is a crop of temperate zone with cool winters and hot summers being very conducive for its growth (Taffesse *et al.*, 2012). Wheat occupies about 17% of the worlds cropped land and contributes 35% of the staple food and its next to rice, so its increased production is essential for food security (Mwadzingeni *et al.*, 2016; Gebreselassie *et al.*, 2017). Wheat cultivated on about 1.69 million hectares and contributing about 4.54 million tons of grain yields, accounting for 15.81% of total grain production in the country in 2016/17 meher cropping season which makes Ethiopia the first wheat producer in sub Saharan Africa (CSA, 2017). Studies revealed that bread wheat covers about 60% of the total wheat area while durum wheat covers 40% (Taffesse *et al.*, 2012). In North Gondar, the total area under wheat production was 38,289 ha in 2016/17 main cropping season (CSA, 2017).

The zonal average productivity of wheat was 2.35 tha^{-1} which is less than the national average yield of 2.67 tha^{-1} (CSA, 2017). Despite the important of wheat to the Ethiopian agriculture, its average yield is still very low as compared to the world average 3.9 tha^{-1} (Faostat, 2016). Low productive of the crop is attributed to the use of old and low yielding varieties, unavailability of modern crop management practice, depilation soil nutrients, poor weed management practices, low level of fertilizer application, water logging in vertisol areas, prevalence of aggressive and virulent crop pathogens (Ashamo *et al.*, 2012). In Ethiopia, a crop yield loss above 36.5% was recorded in wheat in uncontrolled plots (Tana *et al.*, 2018). Similarly, in a study of *Polygonium nepalense, Hypochoeris radicata, Galinsoga parviflora, Avena fatua, Gallium spurium* with bread wheat fields, yield losses of 48-86% were recorded by the maximum weed density of 226 weed seedling per m^2 (Javald, 2010).

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Weeds also show allelopathic effects on agricultural crops by secreting allelochemicals that suppressed their growth and germination (Vissoh *et al.*, 2004; Jabran *et al.*, 2010; Farooq *et al.*, 2011). Although crop yield losses by weeds vary from crop to crop and from region to region, because of various biotic and abiotic factors, it has been estimated that weeds cause a yield loss of about 10% in the less developed country and 25% in the least developed countries (Khan *et al.*, 2015). However, most farmers in Ethiopia do not practice weeding on their fields at appropriate time because of labor shortage and overlapping farm operation; to this fact, most of their fields are weeded lately. Such non effective weed management practice is considered as the main factors for low average yield of wheat, resulting in average annual yield loss of 35% (Bekele *et al.*, 2006; DAMTEW, 2018). Weeds can cause an estimated yield reduction in wheat crops which ranges from 10-65% of the potential production (Tana *et al.*, 2018). Studies indicated that crop losses due to weed competition throughout the world as a whole are greater than those resulting from combined effect of insect pests and diseases (Gella *et al.*, 2013). In Ethiopia weeds compete with cultivated food crops for essential growth factors like light, moisture, nutrients and space (Tamado *et al.*, 2002; Kumar and Agarwal, 2010). Weeds are one of the biotic stress which have contributed to the low level of grain yield, quality of fruits, vegetables, cereals and incurred high level of herbicides cost (Hassannejad and Ghafarbi, 2012; Darfour, 2019). Weed competition reduces yield and consequently farm income. Weeds can also increase the cost of production, restricting operations, reduce the market value of crops and increase the risk of fire in perennial crops, plantation and forest reserves reduce quality of product (Bibi *et al.*, 2008).

Weeds also intensify the disease and insect pest problems by serving as alternate hosts, and uncontrolled weed growth throughout the crop growth caused a yield reduction of 57.6 to 73.2% (Amare, 2014). Generally, weed infestation is the main bottleneck in crop production in Ethiopia, especially during the main rainy season. Uncontrolled weeds caused 58.3% reduction in the wheat grain yield (Sharma, 2009). Although most farmers are less concerned about the negative impact that weeds impose on their crop, study results indicate that weeds share up to 45% of the total annual losses of agricultural products (Belachew and Tessema, 2015). Weed flora composition is strongly associated with regional climate, soil characteristics, and management methods. Previously some studies have been conducted on weed flora and their distribution in Ethiopia (Hedberg *et al.*, 2004; Ermias, 2011), in Eastern Harerge (Tamado and Milberg, 2000), in mid-rift valley of Ethiopia and in Southwestern Ethiopia.

However, detailed information about the prevalence, distribution, occurrence, relative importance and quantitative assessment of the weed species across location has not been well profiled. Therefore, in view of these facts the present study was designed the objectives were to (a) assess the prevalence, distribution and abundance of major weed species on wheat farms; (b) determine the weed species' composition related to their distribution, density and uniformity and (c) assess the effect of weeds on yield attributes and yield of wheat in North Gondar, Ethiopia.

Materials and methods

Description of the surveyed area: To quantify weed prevalence, abundance and diversity as well as its distribution, field survey has been carried out in Amhara national regional state, North Gondar zone. The study was conducted in four wheat producing areas such as Dabat, Debark, Wogera and Gondar Zuria during 2017 and 2018 consecutive cropping seasons. The altitude of the study area ranged from 1,711 to 3,350 m.a.s.l. The zone is located in the North-western part of the country between 11 and 13 North latitude; 35 and 35 East longitude. It is 763km away from Addis Ababa. The weed survey covered the major agricultural zones in Northwestern Ethiopia from Weyna Dega (medium altitude) for altitudes between 1800 and 2400 m and Dega (high altitude) for areas above 2400 m. The total area of the Administrative Zone is 50,970 square km. According to the 2016 census conducted by the Central Statistical Agency of Ethiopia, this zone has a total population of 2,921,470 (84.12% rural and 15.88% urban), of which 51% are men. The study areas have some variations regarding altitude, annual mean temperature and rain fall, soil characteristics cropping pattern, weed management strategy, etc. Despite to the above mentioned factors some weed species frequently occurred in all wheat farms of the study areas. The study area dominated by the agriculture sector employs about 90% of the working force. These areas have hilly and mountainous topography and are the most environmentally degraded and exposed areas. According to the zone agriculture department, farmers use rain fed agriculture mainly for cereal production such as, wheat, maize, sorghum, wheat, barley and teff.

Sampling procedure: In the first stage, four potential wheat producer districts namely, Gondar zuria, Wogera, Dabat, and Debark districts were purposively selected. The districts were selected based on wheat production and productivity in North Gondar zone, and accessibility by road. Out of four district 12 major wheat producing kebele were selected by consulting each district agriculture office expert with experience in wheat commodity. Then after a total of 120 farmer's field produce wheat were selected and inspected for weed prevalence and abundance.

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Finally, using Kebele inhabitants lists, 120 wheat producers were selected by systematic random sampling techniques with the following formula (Goldhaber *et al.*, 1977). Weed flora data were collected from the first year in 65 and the second year in 55 crop fields (total of 120 crop fields). Weed vegetation in the field was sampled in $1m^2$ (1m x 1m) plots located equidistant along a 'W' pattern consisting of three quadrants in each field following the methodology (Thomas, 1985). The number of weed species both in density and cover percentage in each plot was recorded for subsequent data entry and analysis. During field data collection unknown weed specimens were collected for further weed identification and confirmation by using the help of flora of Ethiopia (Hedberg *et al.*, 2004) and also several reference books were consulted for weed identification in the field. The timing of the sampling was chosen so as to coincide with the time of most of the weeds were well established, most of them were in flowering or seed setting stages. Fields were sampled randomly at intervals of 5–10 km along roads and distances between fields depended on the topography and the relative importance of wheat cultivation within each district (Hedberg *et al.*, 2004).

Data analysis: Species dominance index (SDI) was computed to compare the relative contribution of each taxonomic family to weed species composition (Hassannejad and Ghafarbi, 2012). It was calculated as the sum of the relative diversity, relative density and relative coverage as follows

$$\text{Relative weed diversity} = \frac{\text{Number of weed species in families}}{\text{Total number of weed species}} \times 100 \quad (1)$$

$$\text{Relative weed density} = \frac{\text{Nuber of individual in weed families}}{\text{Total number of individuals}} \times 100 \quad (2)$$

$$\text{Relative weed coverage} = \frac{\text{Coverage of individuals in weed families}}{\text{Total coverage of individuals}} \times 100 \quad (3)$$

SDI = Relative weed diversity + Relative weed density + Relative weed coverage (4)

Weed frequency = Number of fields in which a weed species occurred (5)

Where, weed frequency expressed as percentage of the total number of fields surveyed and

Field uniformity = Number of sampling quadrants in which a weed species occurred in surveyed field (6)

Where, field uniformity expressed as percentage of the total number of samples (Tamado and Milberg, 2000).

Density of weed species was estimation applying the following formulas (Mishra, 2013).

$$\text{Absolute density (AD)} = \frac{\text{Total No.of individual of weed species in all sampling quadrants}}{\text{Total number of sampling quadrants}} \times 100 \quad (7)$$

$$\text{Relative density (\%)} = \frac{\text{Absolute density for weed species}}{\text{Total absolute density for all weed species}} \times 100 \quad (8)$$

The qualitative (species) and quantitative structure of weed communities were compared using the Sorensen similarity index (SSI) (Jastrzebska *et al.*, 2013).

$$SSI = 2c \times 100\ (a+b)^{-1} \quad (9)$$

Where c is the total number of weed species shared by the two communities, a is the number of weed species in the first community, b is the number of species in the second community. Similarity index showed the similarity of weed species composition among different districts.

Results and discussion

Weed prevalence and distribution across location: A total of 17 major weed species were recorded on four surveyed districts like Gondar zuria, Wegera, Dabat and Debark from wheat growing farmer fields during 2017 and 2018 consecutive cropping seasons. The most prevailed and widely distributed weed species in all wheat farms of surveyed areas were *Polygonium nepalense* followed by *Hypochoeris radicata* L., *Galinsoga parviflora, Galium hamatum, Avena fatua*, *Gallium spurium*, and *Guizotia scabra* (Table 1). Five broad leaves weed species such as *Polygonium nepalense, Hypochoeris radicata*, *Galinsoga parviflora*, *Galium spurium* and *Guizotia scabra* and one grass weed species such as *Avena fatua* L. were highly distributed in the entire surveyed areas of wheat farms. *Polygonium nepalense* was highly distributed at mid-altitude of Dabat and Gondar zuria than high-altitude of Wogera and Debark districts. However, *Hypochoeris radicata* was highly distributed in high altitude of Debark and Wegera followed by Dabat districts. As survey result indicated that the minimum distribution of *Hypochoeris radicata* was recorded on mid altitude of Gondar zuria districts (Table 1). On the other hand, *Gallium spurium and Galinsoga parviflora* weed species were highly distributed in mid-altitude of Dabat followed by Gondar zuria district than high altitude of Wegera and Debark districts (Table 1). The result indicated that the occurrence of weed flora in different altitude range had different weed species diversity (Hedberg *et al.*, 2004). In some cases, the high altitude weed species diversity in fields was similar to mid altitude weed flora. Some weed species were limited in its occurrence; *Spergula arvensis* and *Guizotia scabra* was prevailed in Dabat and Gondar zuria wheat farms but not found high altitude of Wogera and Debark districts. In the contrary, *Medicago polymorpha, Hyparrhenia rufa* (Nees) *and Eleusine indica* weed species were frequently occurred and highly distributed in Wegera and Debark district wheat farms but not prevailed mid-altitude of Dabat and Gondar zuria districts. However, *Oxalis latifola* weed species was found only Gondar zuria districts (Table 1). *Bidens pilosa, Cynodon dactylon* and *Cynodon nlemfuensis* weed species were rarely occurred in all surveyed districts of wheat farm with difference level of population density.

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Table 1. Weed species density and dry mass on wheat crop fields in North Gondar, Ethiopia during 2017 and 2018 cropping season.

Weed species	Weed families	Weed species density/m²					Weed species dry mass/m², gm				
		Dabat	Gondar zuria	Wogera	Debark	Mean	Dabat	Gondar zuria	Wogera	Debark	Mean
Avena fatua	Poacea	42.57	25.10	76.50	50.84	48.75	8.95	6.56	11.225	9.56	9.07
Bidens pilosa	Asteraceae	7.65	5.46	2.94	1.98	4.51	1.09	0.85	0.01	0.25	0.55
Cynodon dactlylon	Poacea	14.70	0.34	0.88	5.34	5.32	22.27	5.01	6.05	11.02	11.09
Cynodon nlemfuensis	Poacea	10.45	8.45	2.34	1.67	5.73	1.95	0.45	0.05	0.95	0.85
Cyprus rotundas	Poacea	12.45	18.92	3.95	8.10	10.86	13.45	15.34	11.07	12.87	13.18
Cyperus esculentus	Poacea	16.05	10.45	5.45	4.56	9.13	4.01	2.58	1.05	0.65	2.07
Eleusine indica	Poacea	0	0	13.4	16.78	7.55	0	0	2.34	3.75	1.52
Gallium spurium	Rubiaceae	80.40	75.97	62.85	41.03	65.06	14.35	12.46	12.98	11.10	12.72
Galium hamatum L.	Rubiaceae	10.13	5.32	15.08	22.81	13.34	0.95	0.06	1.05	2.34	1.10
Galinsoga parviflora	Asteraceae	93.80	83.8	58.50	44.56	70.17	43.30	30.76	24.42	18.80	29.32
Guizotia scabra	Composite	70.73	42.30	0	0	28.26	21.16	14.56	0	0	8.93
Hyparrhenia rufa (Nees)	Poacaea	0	0	23.45	29.56	13.25	0	0	1.24	2.45	0.92
Hypochoeris radicata	Asteraceae	52.00	3.54	146.04	299.53	125.28	42.18	25.25	92.50	104.25	66.01
Polygonium nepalense	Polygonaceae	271.45	145.35	34.33	89.50	135.16	91.35	73.45	22.71	39.58	56.77
Medicago polymorpha	Fabacea	0	0	20.90	8.50	7.35	0	0	2.34	0.68	0.76
Spergula arvensis	Caryoohyllaceae	30.97	48.40	0	0	19.84	0.56	1.56	0	0	0.53
Oxalis latifola	Oxalidaceae	0	55.25	0	0	13.81	0	3.47	0	0	0.87

Regarding weed diversity both grass and broad leaf weed types were present in the surveyed wheat farms areas (Table 1).

Weed species dry mass: Among identified weed species seven weed species such as *Hypochoeris radicata*, *Polygonium nepalense*, *Galinsoga parviflora, Cyprus rotundas, Gallium spurium, Cynodon dactlylon* and *Avena fatua* were had highly dry mass in the surveyed areas. In the contrary, *Spergula arvensis* weed species was showed lower dry mass (Table 1). Weed dry mass is related with the competitiveness of weed species. The above mentioned four weed species such as *Hypochoeris radicata, Polygonium nepalense*, *Galinsoga parviflora and Cyprus rotundas* have been more competitiveness and that can be reduced crop yields more than other identified weed species in the surveyed areas (Table 1).

Similarity index of weed species: According to Sorensen similarity index (SSI) value of 58.41-86.23%, 43.78-63.67% and 51.34% among the districts of Debark, Gondar zuria and Wegera, respectively. Weed communities of crops grown in Debark with Dabat, Wegera, and Gondar zuria districts were more similar with regard to species composition (SSI of 58.41- 86.23%) while weed species composition was mainly dissimilar between Dabat with Gondar zuria and wegera districts (SSI of 43.78- 63.67%) (Table 2). Dabat district of weed communities with mid-altitude of Gondar zuria and higher altitude of Wegera districts revealed substantially higher similarity with respect to floristic composition of 63.67 and 5.34% SSI than higher altitude of Debark district 82.43% (Table 2). If the similarity index is below 60%, it is said to be that the two locations have different weed communities.

Since similarity index for the different location were greater than 60%, it can be concluded that the locations exhibited similar weed community (Edesi *et al.*, 2012). The SSI result indicated that due to the agro-climatic condition of Dabat was more related to Wegera and Gondar zuria district than higher land agro-climatic condition of Debark districts. The reason behind that was due to the altitude range represents a complex gradient and influences other environmental and crop management variables (Taffesse *et al.*, 2012). Therefore, it can be designed the strategic plan of similar management options.

Weed flora of crop fields: Among a total of 17 weed species, *Polygonium nepalense, Hypochoeris radicata, Galinsoga parviflora Cav. Guizotia scabra (Vis.) Chiov, Gallium spurium*, *Cyprus rotundas* L. were recorded and widely distributed with higher than 30% frequency value while the lower than 20% frequency value was recorded from 7 weed species on surveyed crop fields. The ranking of weeds based on frequency and field uniformity was slightly different (Table 3). The species that had the highest frequency and largest uniformity 35% was *Polygonium nepalense* and followed by 28 and 27% of *Galinsoga parviflora Cav.* and *Hypochoeris radicata* respectively among all surveyed weed flora. Hence, these species were much more frequently recorded and uniformly distributed in fields than other species. The lowest frequency with the lowest uniformity was observed on *Oxalis latifola* weed species (Table 3). The absolute density (AD) value of the species varied from 0.36 to 3.05 plants/m^2. The highest abundance value (3.05 weeds/m^2) was recorded by *Polygonium nepalense* followed by *Hypochoeris radicata* (2.88 weeds/m^2), *Galinsoga parviflora Cav.* (2.53 weeds/m^2) and *Cyprus rotundas* L. (2.27 weeds/m^2).

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Table 2. Similarity index of weed species in four surveyed districts of North Gondar, Ethiopia during 2017 and 2018 cropping season.

Districts	Dabat	Wegera	Gondar zuria	Debark
Dabat	100	51.34	63.67	82.43
Wegera		100	43.78	86.23
Gondar zuria			100	58.41
Debark				100

Table 3.Description of frequency, uniformity, absolute density, and relative density of weed species on crop fields in North Gondar, Ethiopia during 2017 and 2018 cropping season.

Weed species	Family	Frequency (%)	Uniformity (%)	AD (No.)	RD (%)
Avena fatua	Poacea	3.45	2	0.75	0.98
Bidens pilosa L.	Asteraceae	21.04	17	1.16	1.77
Cynodon dactylon (L.) Pers	Poacea	26.74	3	1.75	1.98
Cynodon nlemfuensis Vandryst	Poacea	8.57	19	1.36	2.07
Cyprus rotundas L.	Poacea	32.56	25	2.27	2.98
Cyperus esculentus L.	Poacea	16.78	7	1.26	2.35
Eleusine indica (L.) Gaertn	Poacea	4.56	6	0.87	0.99
Gallium spurium	Rubiaceae	34.67	9	1.82	2.39
Galium hamatum L.	Rubiaceae	4.93	1	0.55	0.84
Galinsoga parviflora Cav.	Asteraceae	38.89	28	2.53	3.13
Guizotia scabra (Vis.) Chiov	Composite	35.46	17	1.13	1.98
Hyparrhenia rufa (Nees)	Poacaea	14.89	4	1.33	2.77
Hypochoeris radicata	Asteraceae	47.23	27	2.88	3.76
Polygonium nepalense	Polygonaceae	54.34	35	3.05	4.88
Medicago polymorpha	Fabacea	21.34	19	1.67	2.04
Spergula arvensis	Caryoohyllaceae	23.45	11	1.18	2.05
Oxalis latifola	Oxalidaceae	3.25	1	0.36	0.76

AD: Absolute density; RD: Relative density; No: Numbers of individual weed species/quadrant.

Whereas, the least abundance value (0.36 weeds m^2) was recorded from *Oxalis latifola* weed species (Table 3). Results of this study showed that *Polygonium nepalense*, *Hypochoeris radicata*, *Galinsoga parviflora Cav.* and *Cyprus rotundas* L. were in the top ranking of weed species in crop fields according to relative density (RD) 4.88, 3.76, 3.13 and 2.98% respectively while the least relative density percentage was indicated by *Oxalis latifola* and *Galium hamatum* L. weed species (Table 3). Mainly the weed species with the higher frequency value was higher relative density value, however, in some cases, the higher frequency value showed lower relative density value when compared with one to the other weed species. The frequency percentage of *Bidens pilosa* L. (21.04%) was greater than the value for *Cynodon nlemfuensis* Vandryst (8.57%); however, the relative density of *Cynodon nlemfuensis* Vandryst was greater than *Bidens pilosa* L. and had values of 2.07 and 1.77%, respectively, conclusively *Cynodon nlemfuensis* Vandryst was more dominant than *Bidens pilosa* L. weed species (Table 3). Dominance of weed species such as *Polygonium nepalense*, *Hypochoeris radicata*, *Galinsoga parviflora Cav.* and *Cyprus rotundas* L. were aggressively wide spread since these weed species grow over years on field crops and that can be reduced on crop yields.

Species dominance index (SDI): Species richness and diversity were generally higher during the cropping season of August up to November. Among weed species, the highest relative diversity of 26.16% was recorded from *Polygonium nepalense* followed by 24.39% and 20.56% on *Hypochoeris radicata* and *Gallium spurium* respectively. While the least relative diversity, 1.67% was recorded from *Bidens pilosa* species of sixteen different weed species (Table 4). Relative density varied among weed species. The highest relative densities of 27.48 and 20.06% were recorded from *Hypochoeris radicata and Polygonium nepalense* weed species respectively. While the third relative density 18.11% was obtained from *Gallium spurium* weed species. Consistently, the higher relative coverage of 20.53, 18.34 and 14.67% were recorded from *Polygonium nepalense*, *Hypochoeris radicata* and *Galinsoga parviflora* which covered the wide range of farming fields among the weed species. On the other hand the lowest relative coverage of 0.05 and 0.36% were recorded from *Cyprus rotundas* and *Bidens pilosa* weed species (Table 4). The main dominant weed species were *Hypochoeris radicata, Polygonium nepalense, Galinsoga parviflora, Gallium spurium and Guizotia scabra* with 70.21, 66.75, 49.80, 49.23 and 35.28% SDI, respectively (Table 4).

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Table 4. Species dominance index of weed flora survey in North Gondar, Ethiopia during 2017 and 2018 cropping season.

Weed species	Family	Relative diversity (%)	Relative density (%)	Relative coverage (%)	SDI (%)
Avena fatua	Poacea	10.25	8.66	6.57	25.48
Bidens pilosa L.	Asteraceae	1.67	0.56	0.36	2.59
Cynodon dactlylon (L.) Pers	Poacea	2.51	4.57	2.06	9.14
Cynodon nlemfuensis Vandryst	Poacea	3.34	1.97	0.47	5.78
Cyprus rotundas L.	Poacea	3.83	0.18	0.05	4.06
Cyperus esculentus L.	Poacea	2.96	0.09	1.08	4.13
Eleusine indica (L.) Gaertn	Poacea	2.23	1.34	1.15	4.72
Gallium spurium	Rubiaceae	20.56	18.11	10.56	49.23
Galium hamatum L.	Rubiaceae	2.38	3.78	2.15	8.31
Galinsoga parviflora Cav.	Asteraceae	19.56	15.57	14.67	49.8
Guizotia scabra (Vis.) Chiov	Composite	11.26	12.79	11.23	35.28
Hyparrhenia rufa (Nees)	Poacaea	1.78	2.67	1.98	6.43
Hypochoeris radicata	Asteraceae	24.39	27.48	18.34	70.21
Polygonium nepalense	Polygonaceae	26.16	20.06	20.53	66.75
Medicago polymorpha	Fabacea	6.54	2.05	1.09	9.68
Spergula arvensis	Caryoohyllaceae	8.43	3.60	1.89	13.92
Oxalis latifola	Oxalidaceae	1.81	1.62	0.98	4.41

SDI: Species Dominance Index.

The top-ranking weeds species *Hypochoeris radicata*, *Polygonium nepalense*, *Galinsoga parviflora* and *Gallium spurium* were the most aggressive and difficult weeds to control in different surveyed areas. High frequency of these weeds showed that they are a serious problem in all agricultural fields. *Hypochoeris radicata* is one of the most invasive weeds known, having spread out to a worldwide distribution in tropical and temperate regions and it has been called "the world's worst weed" (Belachew and Tessema, 2015). In addition, these two weed species (*Hypochoeris radicata*, *Polygonium nepalense*) were producing allelochemicals that retarded the crop growth and further reduced yields. The allelochemicals released from *Hypochoeris radicata*, *Polygonium nepalense* inhibit the growth of pasture grasses, legumes, cereals, vegetables, other weeds, and even trees (Mishra, 2013; Kaur *et al.*, 2014). The relative higher score of SDI *Hypochoeris radicata*, *Polygonium nepalense*, *Galinsoga parviflora* and *Gallium spurium* were recorded due to the greater number of species and better adaptability under dominant environmentally conditions compared to other species. The survey result showed that the most important species in North Gondar Ethiopia based on the number of taxa and SDI were *Hypochoeris radicata*, *Polygonium nepalense*, *Galinsoga parviflora* and *Gallium spurium* species. These four species were also the most important in small-scale farming in Eastern and Southwestern Ethiopia (Berhe and Sharma, 2011). The weed flora in crop fields of Northwestern Ethiopia as dominated by few common species, which is a common phenomenon in extensive farming systems (Ermias, 2011).

It seems that in arable lands due to continuous tillage, growth conditions are more favorable for annual weeds in comparison with perennial weeds (Hassannejad and Ghafarbi, 2012).

The most difficult and dominant weeds: The most difficult weeds to control in surveyed districts were *Hypochoeris radicata*, *Polygonium nepalense*, *Galinsoga parviflora*, *Gallium spurium, Guizotia scabra and Avena fatua* (Table 2). Especially most farmers reported that *Hypochoeris radicata* weed grew in dense stands and subsequent generations always came up soon after removal of one generation. *Hypochoeris radicata* was the most difficult weed to control in high altitude areas. Invasive species are concern because of their capability of spreading fast, their high competitiveness and ability to colonize new areas within short periods (Gbèhounou, 2013). The nature and severity of the impacts of these species on society, economic life, health and national heritage are of global concern (Jastrzebska *et al.*, 2013). *Polygonium nepalense* and *Galinsoga parviflora* were found as a serious problem particularly in Dabat and Gondar zuria districts with the heaviest infestations being on wheat crop fields. Field observation during the survey revealed that once the weed was more than one and a half months old from the time of emergence, it became very difficult to remove manually or mechanically. If the weed is removed by hand or mechanically, stems break off and root at the nodes, producing new plants. Thus, weeding may indirectly multiply the plant. Control at that stage would be difficult except probably by the use of chemicals. Over 30% of visited farmers' fields showed that weeds and crops of the same size before the first weeding was observed.

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This is too late to remove weeds as the detrimental effects of weeds on crop growth and final yield would have great loss. Most farmers tended not to remove weeds.

Conclusion

The relative economic importance of major weed species was varied among their surveyed districts. The purpose of this field survey was to assess the status of most important wheat weed species. The most aggressive and difficult-to-control weeds in the survey have been identified in the survey at different altitudes. As a result, *Polygonium nepalense, Hypochoeris radicata, Galinsoga parviflora, Avena fatua, Gallium spurium,* and *Medicago polymorpha* were the most dominate and frequently occurring weeds of wheat, during the two-year survey across districts of North Gondar zone, Ethiopia. Information about weed prevalence and their abundance in each district would be beneficial in the selection of essential weed management strategies and necessary to sufficiently describe the relative ranking of weeds. The most aggressive and difficult-to-control weeds in the survey have been identified in the survey at different altitudes. Hence, the results of this study suggest the importance of research on cultural practices to supplement effective integrated weed management practices in the surveyed areas. Furthermore, extensive and consistent survey is suggested to know the intensity of the weeds in similar agro-ecology of the country where the crop is widely grown.

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