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Determination of population indices and weed distribution map in barley fields of Kermanshah Province, Iran

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Abstract

Weed detection of irrigated barley fields can be considered as the most important strategy for weed management of in this crop. Based on cropping area of barley and frequency of fields in each county of Kermanshah province, barley fields were selected. In order to identify and determine the abundance of weed species in irrigated barley fields of Kermanshah province, Iran, 142 barley fields in eight counties during 2001 to 2009 were investigated. Samplings were conducted using a unique method for all fields. Geographic coordinates of fields (latitude, longitude and elevation) were determined using GPS. Density, frequency and uniformity of each weed species was calculated. A geodatabase was designed using ArcGIS software, and finally the weed map of irrigated barley fields were produced. There are 53 weed species in irrigated barley fields. Bedstraw*(Galium tricornutum* Dandy.*), Centaurea depressa* and *Vicia villosa* are the most important broad leaved weed species respectively and Wild barley (*Hordeum spontaneum* C. Koch.) and winter wild oat (*Avena ludoviciana* Dur.), are the most important grass weed species respectively in irrigated barley fields.Licorice root (*Glycyrrhiza glabra*), *Sophora alopecuroides* and *Cirsium arvense* were the most widely disturbing plants in barley fields of Kermanshah province prior to harvesting respectively. Analysis of weed population based on Shannon-Wiener diversity index showed that the counties were grouped in three clusters. Javanroud, Songhor, Sahne, Kangavar, Harsin and Kermanshah were placed in first cluster and showed the highest species diversity. Sarpole zohab and Eslamabade gharb counties were placed in the second and third cluster respectively.

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Introduction

Some surveys about weed flora and distribution have been done in Iran (Dezyanian 1994; Veisi *et al.,* 2012, 2013; Kakhki *et al*., 2013; Esfandiari *et al.,* 2013), Canada (Thomas, 1985, 1991), Finland (Salonen *et al.,* 2001), Turkey (Bukun and Barbaros, 2005), Pakistan (Nasir and Sultan, 2004),Bulgaria (Milanova *et al.,* 2009), Denmark (Andreasen and Skovgaard, 2009), France (Fried *et al.,* 2008), Hungray (Novak *et al.,* 2010), the UK (Bachthaler, 1967; Fryer and Chancellor, 1970) and the US (Conn *et al.,* 2011).

It lacks an overall quantitative method capable of assessing the weed flora in all crops. This gap in our knowledge led us to initiate a study in order to find a relevant method to study weed populations, through the determination of an abundance index (AI) for each species (Minbashi Moeini *et al.,* 2008).

The weeds occurring in Iranian wheat fields represent a high production loss (Montazeri *et al.,* 2005).

Weed survey methods have been introduced by many scientists (McCully *et al.,* 1991; Thomas 1991; Thomas and Dale 1991; Schroeder *et al.,* 1993).

For collecting data on the ground, Global Positioning System (GPS) receivers are common place. GPS is a satellite navigation system developed by the Department of Defense that can pinpoint a location anywhere on earth. GPS receivers are able to obtain signals from satellites orbiting the earth. (Walker *et al.,* 2000).

We use GIS database for identify populations of unwanted plants, Locate problem areas, determine acres infested, determine acres infested, assess economic impact of infestation, estimate change over time, record and study effectiveness of treatments, establish historical weed inventory (Anonymous, 2015).

Adim (2009) and Adim *et al.* (2010) determined the diversity, density and frequency of wheat weeds, in the four administrative divisions of Sistan and Baluchestan province.

Mapping of weed distribution and their demogeraphic indices would be an important step forward in the weed management in the barley fields. Monitoring of weed species in the region will provide great help to make a decision on applying proper control measures (Minbashi Moeini *et al.,* 2008).

Esfandiari *et al.* (2013) showed that 85 weed species were observed within irrigated barley fields of Esfahan province. The most important broadleaved weed species were *Polygonum aviculare*, *Chenopodium album* and S*isymbrium irio*, respectively. Dominant grass weed species were *Avena ludoviciana, Secale cereale* and *Phalaris minor*. Besides *Convolvulus arvensis, Cardaria draba* and *Alhagi pseudalhagi* were the most important disturbing plants prior to harvesting in barley fields of Esfahan province respectively.

Hasanejad *et al.* (2009) determined 219 weed species from 36 families in the barely fields. Among 219 species recorded, 107 species occurred in more than three township and 120 species occurred in more than three fields (Hasanejad *et al.,* 2009).

Because barley is a forage crop in Kermanshah province, many farmers do not use herbicides to control weeds, also weed density is high in this cultivation. This action increases the soil seed bank in the next rotation crop. The need to study the population indices in barley fields is essential.

The objective of this study was to identify the dominant weed species in the barley fields and to map the distribution and the abundance of each species in the barley fields of Kermanshah province.

Materials and methods

Weed sampling methods

Kermanshah province, Iran, comprises an area of 24640 km² and is located between 33°37′-35°17′N

and 45°20′-48°1′E. The average annual precipitation is 450 mm. Most of the fields surveyed in this study lie between 542 and 1554 m a.s.l. Weed samplings were performed during eight years (2002 to 2009) from 142 barley fields in 8 counties (kangavar, Kermanshah, Eslamabade gharb, Harsin, Sahne, Sarpole zohab, Songhor, Javanroud) of Kermanshah province, Iran. The number of fields surveyed in each county was based on its area under barley cultivation (Minbashi moeini *et al.,* 2008). The selection of the fields in each county was done based on their frequency in the county and with respect to these three scales: (i) barley fields between 1 and 5 ha; (ii) wheat fields between 6 and 15 ha; and (iii) wheat fields >15 ha (Minbashi Moeini *et al.,* 2008). The time for sampling in the different regions of the province started by beginning of stem elongation until the end of heading stages of barley. Geographical characteristics of each field (longitude, latitude and elevation) were recorded using the GPS. After throwing a 0.25 m^2 quadrate, the genus and species of weeds were precisely identified and then the number of weeds from each species was counted separately in each quadrate.

Statistical analysis

According to table 1 frequency, uniformity, density, mean density, abundance index of species, FIV (Family important value), evenness, and shanon-wiener indices, in each county were calculated (Table 1).

After calculating the, Shannon-Wiener index, and evenness index in the 8 counties, we used cluster analysis for comparison and classification of the counties using the software spss (Mesdaghi, 2005).

After performing the necessary calculations and the determination of the population indices of weeds, the geographical characteristics of each surveyed field was recorded and transferred to the form of a database which was in Access. The database layers in GIS were drawn. In the first step, the information listed in the software Arc Map from the collection of software Arc GIS, based on longitude and latitude were recorded and a point data layer was provided. Then the main information layer of the various weeds species was prepared. In the next step by using the Overlay techniques in GIS, this information was connected to the map of Kermanshah province georefrence. Finally, the distribution maps of different weeds species of barley fields were produced for Kermanshah province.

Results and discussion

Eslamabade gharb county

The most frequently occurring broad leaf weeds in the barley fields in the Eslamabade gharb county include *Glycyrrhiza glabra* L. *Galium tricornutum* Dandy., *Papaver rhoeas* L. and *Vicia villosa* Roth (Table 2).

The most frequently occuring grass weed speciesin the barley fields in the Eslamabade gharb county includes *Hordeum spontaneum*. *Glycyrrhiza glabra*, *Convolvulus arvensis* and *Sophora alopecuroides* were the most important disturbing plants prior to harvesting in barley fields (Table 2).

Harsin county

The most frequently occurring broad leaf weeds in the barley fields in the Harsin county include *Vicia assyriaca,Galium tricornutum* and *Galium aparine* (Table 3). The most frequently occuring grass weed species in the barley fields in the Harsin county include *Avena ludoviciana* Dur.*, Cardaria draba and Carthamus oxycantha,* were the most important disturbing plants prior to harvesting in barley fields (Table 3).

Kangavar county

The most frequently occurring broad leaf weeds in the barley fields in the Kangavar county include *Galium tricornutum, Centaurea depressa* and *Rapistrum rugosum* (Table 4). The most frequently occuring grass weed species in the barley fields in the Kangavar county include *Avena ludoviciana* and *Hordeum spontaneum*. *Glycyrrhiza glabra* and *Cichorium intybus* were the most important disturbing plants prior to harvesting in barley fields (Table 4).

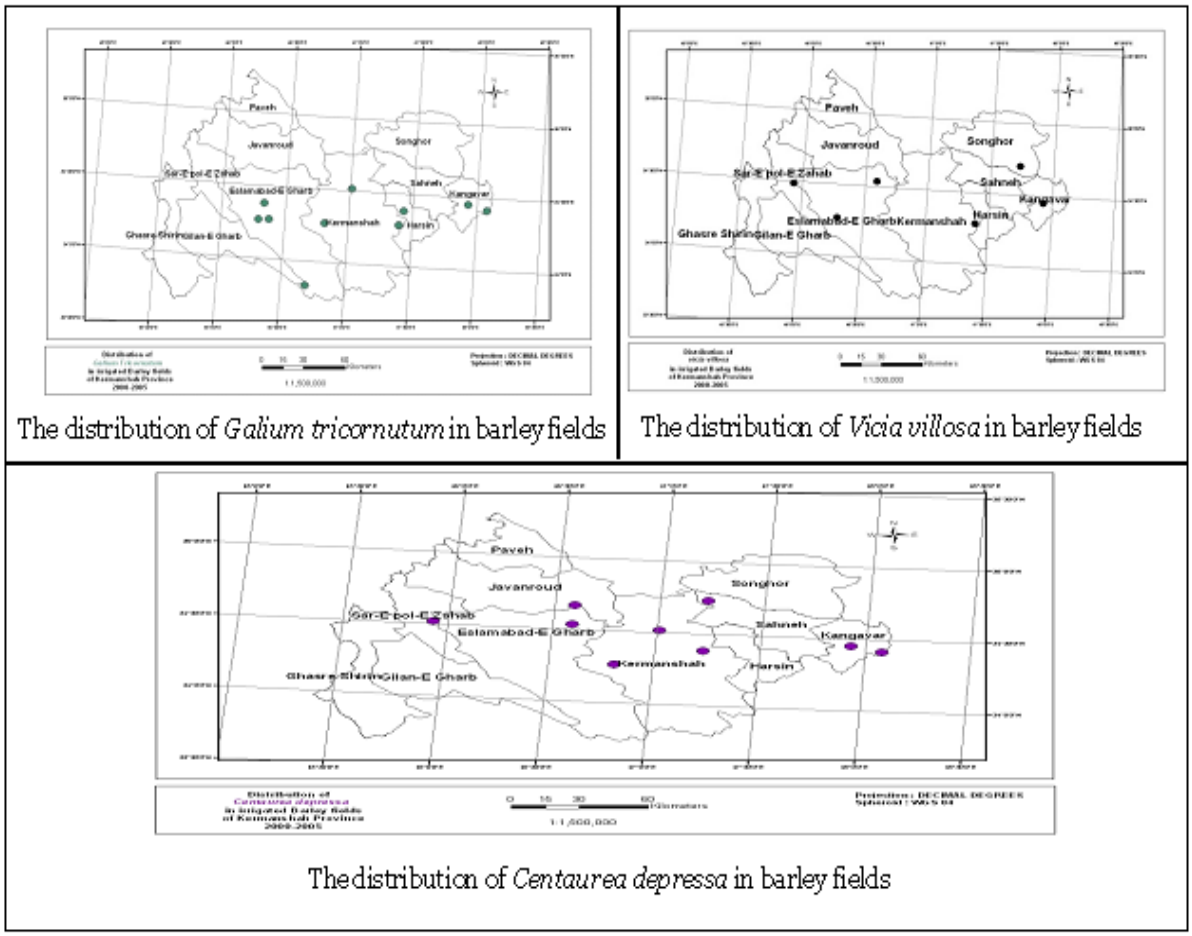

Fig. 1. The distribution of the dominant broadleaved weed species in barley fields in the Kermanshah province.

Kermanshah county

The most frequently occurring broad leaf weeds in the barley fields in the Kermanshah township include *Galium tricornutum, Galium aparine* and *Sinapis arvensis* (Table 5). The most frequently occuring grass weed species in the barley fields in the Kermanshah county include *Hordeum spontaneum* and *Avena fatua*. *Glycyrrhiza glabra*, *Sophora alopecuroides* and *Carthamus oxycantha* were the most important disturbing plants prior to harvesting in barley fields (Table 5).

Sahne county

The most frequently occurring broad leaf weeds in the barley fields in the Sahne county include *Cephalaria syriaca, Malva parviflora and Anthemis cotula* (Table 6). The most frequently occuring grass weed species in the barley fields in the Sahne county include *Hordeum spontaneum*. *Glycyrrhiza glabra*, *Sophora alopecuroides* and *Phragmites australis* were the most important disturbing plants prior to harvesting in barley fields (Table 6).

Sarpole zohab county

The most frequently occurring broad leaf weeds in the barley fields in the Sarpole zohab county include *Vicia villosa*,*Vicia assyriaca and Papaver rhoeas* (Table 7). The most frequently occuring grass weed species in the barley fields in the Sarpole zohab county include *Hordeum spontaneum, Avena ludoviciana*, *Phalaris minor* and *Lolium perenne*. *Silybum marianum* were the most important disturbing plants prior to harvesting in barley fields (Table 7).

Songhor county

The most frequently occurring broad leaf weeds in the barley fields in the Songhor county include *Vicia*

villosa, *Anthemis cotula* and *Lisaea heterocarpa* (Table 8). *Sophora alopecuroides* and *Cirsium arvense* was the most important disturbing plants prior to harvesting in barley fields (Table 8).

Javanroud county

The most frequently occurring broad leaf weeds in the barley fields in the Javanroud county include *Lamium amplexicaule*, *Papaver rhoeas and Lisaea heterocarpa* (Table 9). *Falcaria scioides*, *Cirsium arvense* and *Cardaria draba* were the most important disturbing plants prior to harvesting in barley fields (Table 9).

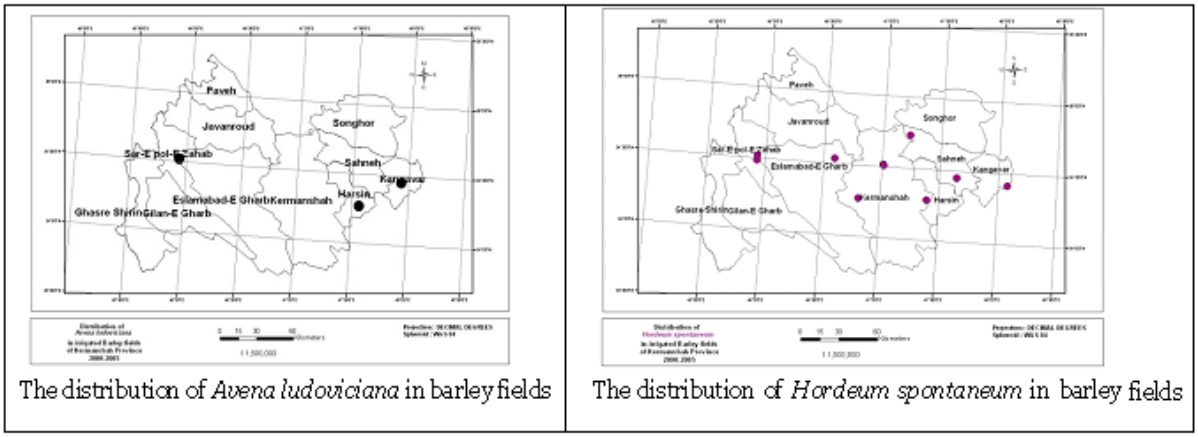

Fig. 2. The distribution of the dominant grass weeds species in barley fields in the Kermanshah province.

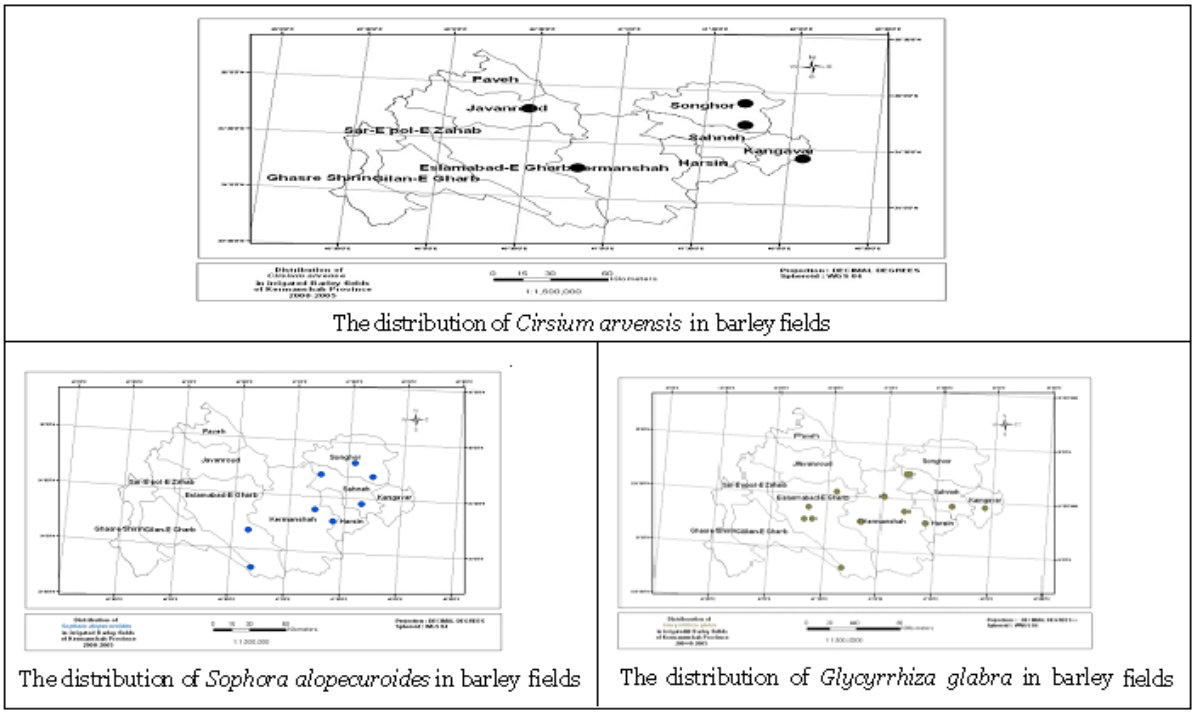

Fig. 3. The distribution of the most important disturbing plants prior to harvesting in barley fields in the Kermanshah province.

Kermanshah province

Based on the data, 53 weed species was observed within barley fields in Kermanshah province. Based on the results obtained on the dominant weed species within barley fields of 8 counties of Kermanshah province (Tables 2 to 9) we can conclude that the

most important broadleaved weed species within barley fields of Kermanshah province were *Galium tricornutum, Centaurea depressa and Vicia villosa* respectively. Fig.1 shows the distribution of these species in barley fields in the Kermanshah province. The most dominant grass weed species were *Hordeum spontaneum* and *Avena ludoviciana* respectively. Fig.2 shows the distribution of these species in barley fields in the Kermanshah province. Veisi *et al.* (2013a) demonstrated that the growth of Wild barley (*Hordeum spontaneum*) and wild oat (*Avena ludoviciana*) were positively correlated in soils with high levels of nitrogen in Kermanshah province. Nekahi *et al.* (2013) determined that the most dominant weeds were *Phalaris minor, Sinapis arvensis* and *Avena Ludoviciana* in Bandar Gaz Golestan province. *Glycyrrhiza glabra*, *Sophora alopecuroides* and *Cirsium arvense* were the most widely disturbing plants in barley fields of Kermanshah province prior to harvesting respectively. Fig.3 shows the distribution of these species in barley fields in the Kermanshah province.

The most weed population was observed in Kermanshah county with 153.68 plant per square meter and the least weed population was observed in Javanroud county with 30.8 plant per square meter (Fig.4).

Kangavar county has high diversity in the barley fields in Kermanshah province while the Eslamabade gharb has low diversity in barley fields.

Table 1. Population, evenness, and diversity indices.

Index	Name of the indicator	References	formula
Population indices	Frequency	[Thomas, 1985]	$F_k = \frac{\sum Yi}{n} * 100$
	Uniformity	[Thomas, 1985]	$U_k = \frac{\sum_1^n \sum_1^m x_{ij}}{\sum_1^m m}$
	Density (plant per square meter) of the species	[Thomas, 1985]	$D_{ki} = \frac{\sum_1^m Z_j}{m} * 4$
	Mean field density of the species	[Thomas, 1985]	$MFD_{ki} = \frac{\sum_1^n D_{ki}}{n}$
	Abundance Index of the species	[Minbashi Moeini *et al.*, 2008]	AIk= Fk + Uk+ MFDk
	Family important value	[Hasanejad and Pourhaidar Ghafarbi, 2012]	FIV=$Relativediversity + Relativedensity$
Evenness	Simpson	[Boot *et al.*, 2003]	E= H'/Ln S
	Shannon-Wiener	[Boot *et al.*, 2003]	H'=Σ [Pi (Ln Pi)]
	variance of Shannon - Wiener	[Boot *et al.*, 2003]	H'var =1/N × {ΣPi (Ln Pi) 2 – [ΣPi (Ln Pi)] 2}
Diversity	The degrees of freedom	[Boot *et al.*, 2003]	df=(H'var1 + H'var2) / [(H'var12/a)+ (H'var22/b)]
	observed t.	[Boot *et al.*, 2003]	tobs= (H'1 - H'2) / [(H'var1) + (H'var2)]$^{0.5}$

Ranking by FIV showed that the dominance families in Kermanshah barley fields were Fabaceae, Poaceae, Asteraceae and Rubiaceae with 45, 38.5, 28.4 and 26.8 FIV, respectively (Fig.5a).

Ranking by species number showed that the most families in Kermanshah barley fields were Poaceae, Asteraceae, Brassicaceae, Fabaceae, and Apiaceae with 16, 17, 15, 11 and 8 percentage, respectively (Fig.5b).

Analysis of weed population based on Shannon-

Wiener (H′) diversity index showed that the counties were grouped in three clusters (Fig.6). Javanroud, Songhor, Sahne, Kangavar, Harsin and Kermashah with the values 2.14, 2.14, 2.43, 2.07, 2.07 and 2.41 respecively were placed in first cluster and showed the highest species diversity. Sarpole zohab and Eslamabade gharb counties were placed in the second and third cluster respectively (Fig.6). Hasanejad *et al.* (2009) expressed that Hashtrud, Kaleybar and Jolfa with 93, 87 and 82 species, respectively, had maximum diversity in weed community and Malekan, Garaaghaj and Ajabshir with 10, 21 and 22 species, respectively had minimum diversity in barley fields in Tabriz province.

Table 2. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 19 weed species collected during the 2002–2009 survey in barley fields of Eslamabade gharb county, Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	UnifromatY (%)	Mean density (plant/m²)	Abundance index
1	*Glycyrrhiza glabra* L.	Fabaceae	83.33	76.47	10.25	170.05
2	*Galium tricornatum* Dandy.	Rubiaceae	66.66	37.5	5.24	109.4
3	*Vicia villosa* Roth	Fabaceae	33.33	26.47	2.72	62.52
4	*Convolvulus arvensis* L.	Convolvulaceae	33.33	26.47	1.4	61.2
5	*Sophora alopecuroides* L.	Fabaceae	33.33	23.52	1.46	58.31
6	*Papaver rhoeas* L.	Papaveraceae	33.33	23.52	0.78	57.63
7	*Adonis flammea* jacq.	Ranunculaceae	33.33	20.52	1.2	55.05
8	*Vicia assyriaca*Boiss.	Fabaceae	33.33	17.64	3.46	54.43
9	*Centaurea depressa* M.B.	Asteraceae	33.33	8.82	0.53	42.68
10	*Geranium tuberosum* L.	Geraniaceae	16.66	11.67	10.8	39.13
11	*Conringia orientalis* (Gay) Schrod	Brassicaceae	16.66	17.64	0.51	34.81
12	*Hordeum spontaneum* C. Koch	Poaceae	16.66	13.33	0.22	30.21
13	*Cephalaria syriaca* (L.) Roemer&Schults	Dipsacaceae	16.66	11.76	1.06	29.48
14	*Euphorbia helioscopia*	Euphorbiaceae	16.66	8.82	0.66	26.14
15	*Descurania Sophia* (L.) Webb & Benth	Brassicaceae	16.66	8.28	0.93	25.87
16	*Anthemis cotula* L.	Asteraceae	16.66	5.88	0.93	23.47
17	*Vicia monantha* Retz.	Fabaceae	16.66	5.88	0.66	23.2
18	*Malva parviflora* L.	Malvaceae	16.66	5.88	0.4	22.94
19	*Carthamus oxycantha* M.B.	Asteraceae	16.66	2.58	0.66	19.9

Table 3. Scientific name, family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 10 weed species collected during the 2002–2009 survey in barley fields of Harsin county, Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Cardaria draba* L.	Brassicaceae	100	80	2.2	182.2
2	*Vicia assyriaca*	Fabaceae	100	70	5.2	175.2
3	*Galium aparine* L.	Rubiaceae	50	80	9.8	139.8
4	*Galium tricornatum* Dandy.	Rubiaceae	50	80	9.8	139.8
5	*Carthamus oxycantha* M.B.	Asteraceae	50	50	3.2	103.2
6	*Anthemis cotula* L.	Asteraceae	50	50	1.4	101.4
7	*Sisymbrium irio* L.	Brassicaceae	50	50	1.3	101.3
8	*Geranium tuberosum* L.	Geraniaceae	50	40	3.4	93.4
9	*Avena ludoviciana* Dur.	Poaceae	50	40	3.2	93.2
10	*Stellaria media* (L.) Vill.	Caryophyllaceae	50	40	2.2	92.2

Analysis of weed population based on Simpson`s diversity index showed that the counties were grouped in three clusters (Fig.7). The data shows that the Eslamabade gharb County with the lowest uniformity of weed species (0.17) was placed in third cluster (Fig.7). The lower value of Simpson's diversity index in the Eslamabade gharb County is verified with the low index of Shannon-Wiener and both

together imply that the society is not uniform. High Simpson's diversity index addresses high diversity and absence of the dominant species in weed society and on the contrary its low values imply that some species occur with high density (Hasanejad *et al.,* 2009).

Table 4. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 11 weed species collected during the 2002–2009 survey in barley fields of Kangavar county,Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Galium tricornatum* Dandy.	Rubiaceae	100	92.85	10.55	203.4
2	*Centaurea depressa* M.B.	Asteraceae	100	50	3.2	153.2
3	*Rapistrum rugosum* L. All	Brassicaceae	50	50	2.65	102.65
4	*Avena ludoviciana* Dur.	Poaceae	50	42.85	3.3	96.15
5	*Glycyrrhiza glabra* L.	Fabaceae	50	42.85	1.75	94.6
6	*Vicia villosa* Roth	Fabaceae	50	42.85	1.4	94.25
7	*Cichorium intybus* L.	Asteraceae	50	28.57	2.8	81.37
8	*Vaccaria grandiflora* (Fisch & DC.) jaub & Spach	Caryophyllaceae	50	28.57	0.7	79.27
9	*Hordeum spontaneum* C.Koch	Poaceae	50	21.42	2.8	74.22
10	*Cephalaria syriaca* (L.) Roemer&Schults	Dipsacaceae	50	21.42	1.6	73.02
11	*Cirsium arvense* L. Scop.	Asteraceae	50	14.28	0.3	64.58

Table 5. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 29 weed species collected during the 2002–2009 survey in barley fields of Kermanshah county,Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Glycyrrhiza glabra* L.	Fabaceae	87.5	60.4	26.02	173.92
2	*Galium aparine* L.	Rubiaceae	62.5	37.5	29.11	129.11
3	*Galium tricornatum* Dandy.	Rubiaceae	62.5	37.5	29.11	129.11
4	*Hordeum spontaneum* C.Koch	Poaceae	50	35.41	18.5	103.91
5	*Sinapis arvensis* L.	Brassicaceae	37.5	31.25	9.12	77.87
6	*Anthemis cotula* L.	Asteraceae	37.5	20.83	12.75	71.08
7	*Turgenia latifolia (*L.) Hoffm	Apiaceae	37.5	25	1.68	64.18
8	*Avena fatua* L.	Poaceae	25	27.08	3.55	55.63
9	*Centaurea depressa* M.B.	Asteraceae	37.5	12.5	2.9	52.9
10	*Vaccaria grandiflora* (Fisch & DC.)jaub& Spach	Caryophyllaceae	25	25	0.57	50.57
11	*Sophora alopecuroides* L.	Fabaceae	25	22.91	2.21	50.12
12	*Carthamus oxycantha* M.B.	Asteraceae	12.5	25	0.7	38.2
13	*Vicia hyrcanica* Fisch& C.A. Mey	Fabaceae	12.5	20.83	3.1	36.43
14	*Euphorbia cyparissias* L.	Euphorbiaceae	25	8.33	1.07	34.4
15	*Euphorbia helioscopia* L.	Euphorbiaceae	25	8.33	1.07	34.4
16	*Vicia villosa* Roth.	Fabaceae	12.5	20.83	0.44	33.77
17	*Cephalaria syriaca*(L.) Roemer & Schults	Dipsacaceae	12.5	16.16	0.66	29.32
18	*Cichorium intybus* L.	Asteraceae	12.5	14.58	0.72	27.8
19	*Sorghum halepense* (L.) Pers	Poaceae	12.5	11.36	2.1	25.96
20	*Phragmites australis* (Cav.)TrinK,ex Steud. var. australis	Poaceae	12.5	10.41	2	24.91
21	*Lithospermum arvense* L.	Caryophyllaceae	12.5	8.33	2.2	23.03
22	*Raphanus raphanistrum* L.	Brassicaceae	12.5	8.33	1.4	22.23
23	*Anchusa italica* Retz	Boraginacea	12.5	8.33	0.6	21.43
24	*Descurania* Sophia(L.) Webb & Berth	Brassicaceae	12.5	8.33	0.5	21.33
25	*Bupleurum croceum* Fenzl.	Apiaceae	12.5	6.25	0.6	19.35
26	*Malva parviflora* L.	Malvaceae	12.5	4.16	0.5	17.16
27	*Convolvulus arvensis* L.	Convolvulaceae	12.5	2.08	0.2	14.78
28	*Falcaria vulgaris*Bernh	Apiaceae	12.5	2.08	0.2	14.78
29	*Cirsium arvense* L. Scop.	Asteraceae	12.5	2.08	0.1	14.68

Table 6. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 19 weed species collected during the 2002–2009 survey in barley fields of Sahne county,Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Hordeum spontaneum* C.Koch	Poaceae	60	88.88	6.91	155.79
2	*Glycyrrhiza glabra* L.	Fabaceae	60	66.66	10.14	136.8
3	*Hordeum bulbosum* L.	Poaceae	80	55.55	0.71	136.26
4	*Cephalaria syriaca*(L.) Roemer&Schults	Dipsacaceae	40	77.77	2.48	120.25
5	*Sophora alopecuroides* L.	Fabaceae	40	36.36	5.35	81.71
6	*Malva parviflora* L.	Malvaceae	20	55.55	1.54	77.09
7	*Anthemis cotula* L.	Asteraceae	20	55.55	0.53	76.08
8	*Descurania Sophia* (L.) Webb & Benth	Brassicaceae	20	44.44	0.8	65.24
9	*Centaurea depressa* M.B.	Asteraceae	20	44.44	0.71	65.15
10	*Goldbachia laevigata* (M.B.) Dc.	Brassicaceae	20	44.44	0.71	65.15
11	*Sinapis arvensis* L.	Brassicaceae	40	18.18	1.28	59.46
12	*Lisaea heterocarpa* (D.C.)Boiss	Apiaceae	20	33.33	1.95	55.28
13	*Phragmites australis* (Cav.)TrinK,ex Steud. var. australis	Poaceae	20	12.12	4	36.12
14	*Chrozohpora tinctoria* (L.) juss	Euphorbiaceae	20	12.12	1.12	33.24
15	*Convolvulus arvensis* L.	Convolvulaceae	20	9.09	1.12	30.21
16	*Raphanus raphanistrum* L.	Brassicaceae	20	9.09	0.8	29.89
17	*Turgenia latifolia* (L.) Hoffm	Apiaceae	20	9.09	0.52	29.61
18	*Bromus tectorum* L.	Poaceae	20	6.06	0.48	26.54
19	*Acroptilon repens* L. (D.C.)	Asteraceae	20	6.06	0.32	26.38

Table 7. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 11 weed species collected during the 2002–2009 survey in barley fields of Sarpole zohab county,Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Hordeum spontaneum* C.Koch	Poaceae	100	60	3.6	163.6
2	*Avena ludoviciana* Dur.	Poaceae	50	30	33.2	113.2
3	*Vicia villosa* Roth.	Fabaceae	50	40	2.8	92.8
4	*Silybum marianum* (L.) Gaertn.	Asteraceae	50	40	2.4	92.4
5	*Phalaris minor* Retz	Poaceae	50	30	3.2	83.2
6	*Vicia assyriaca* Boiss.	Fabaceae	50	20	12.8	82.8
7	*Papaver rhoeas* L.	Papaveraceae	50	30	2.4	82.4
8	*Lolium perenne* L.	Poaceae	50	30	1.6	81.6
9	*Prosopis fracta* (Banks& Soland). Macbr.	Fabaceae	50	30	1.6	81.6
10	*Centaurea depressa* M.B.	Asteraceae	50	20	1.6	71.6
11	*Conringia orientalis* (Gay) Schrod	Brassicaceae	50	20	0.8	70.8

Table 8. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 13 weed species collected during the 2002–2009 survey in barley fields of Songhor county,Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Sophora alopecuroides* L.	Fabaceae	66.66	73.68	11.7	152.04
2	*Cirsium arvense* L. Scop.	Asteraceae	66.66	47.36	3.17	117.19
3	*Vicia villosa* Roth.	Fabaceae	33.33	36.84	2.81	72.98
4	*Anthemis cotula* L.	Asteraceae	33.33	26.31	2	61.64
5	*Lisaea heterocarpa* (D.C.)Boiss	Apiaceae	33.33	21.05	2.4	56.78
6	*Polygonum aviculare* L.	Polygonaceae	33.33	15.78	3.2	52.31
7	*Chrozohpora tinctoria* (L.) juss	Euphorbiaceae	33.33	15.78	2.1	51.21
8	*Descurania sophia*(L.) Webb & Benth	Brassicaceae	33.33	15.78	2.1	51.21
9	*Acroptilon repens* L. (D.C.)	Asteraceae	33.33	15.78	1.06	50.17
10	*Sonchus asper* (L.) Hill.	Asteraceae	33.33	10.52	1.8	45.65
11	*Lamium amplexicaule* L.	Fabaceae	33.33	10.52	0.53	44.38
12	*Sinapis arvensis* L.	Brassicaceae	33.33	10.52	0.53	44.38
13	*Hypecoum pendulum* L.	Papaveraceae	33.33	5.26	0.34	38.93

The observed T (t_{obs}) between the Kangavar and Harsin county was lower than 2 and tcrit with degrees of freedom calculated for any counties at p=0.05 was lower than 1.96 (Boot *et al.,* 2003). Since the T observed (t_{obs}) was lower than tcrit (Table 10), there was not a significant and statistical difference between the weed societies of Kangavar County with the Harsin county. Comparisons performed by t-test showed that there was no significant difference between the weed society of Harsin and Javanroud, songhor and Kermanshah, Songhor and Sahne counties (Table10).

Table 9. Scientific name,family, frequency (F), uniformity (U), mean density (MD), abundance index (AI) of 9 weed species collected during the 2002–2009 survey in barley fields of Javanroud county,Kermanshah, Iran.

No.	Weed	Family	Frequency (%)	Unifromaty (%)	Mean density (plant/m2)	Abundance index
1	*Lamium amplexicaule* L.	Lamiaceae	100	60	4.8	164.8
2	*Falcaria vulgaris* Bernh	Apiaceae	100	30	3.6	133.6
3	*Cirsium arvense* L. Scop.	Asteraceae	50	30	4.8	84.8
4	*Papaver rhoeas* L.	Papaveraceae	50	30	4.8	84.8
5	*Cardaria draba* L.	Brassicaceae	50	30	3.2	83.2
6	*Lisaea heterocarpa* (D.C.)Boiss.	Apiaceae	50	30	2.4	82.4
7	*Polygonum aviculare* L.	Polygonaceae	50	30	2	82
8	*Cichorium intybus* L.	Asteraceae	50	30	1.6	81.6
9	*Centaurea depressa* M.B.	Asteraceae	50	20	3.6	73.6

Table 10. tobservation (t_{obse}) and degree of freedom (df) for surveyof present or absent of difference in weed diversity incounties of Kermanshah province by Shannon- Wiener variance.

county	Harsin	Javanroud	Kangavar	Sarpole	Songhor	Eslamabade gharb	Sahne	Kermanshah
Harsin		0.55^{ns}	0.02^{ns}	2.29^{**}	0.5^{ns}	3.99^{**}	1.99^{ns}	2.52^{**}
Javanroud	65		0.44^{ns}	3.02^{**}	0.16^{ns}	4.25^{**}	1.83^{*}	2.58^{**}
Kangavar	59	42		1.98^{ns}	045^{ns}	3.86^{**}	1.76^{*}	2.05^{**}
Sarpole zohab	107	85	85		2.36^{**}	2.86^{**}	3.69^{**}	4.42^{**}
Songhor	61	44	65	85		4.05^{**}	1.25^{ns}	1.4^{ns}
Eslamabade gharb	50	46	56	57	58		4.73^{**}	4.9^{**}
Sahne	73	54	72	100	74	57		0.11^{ns}
Kermanshah	112	161	58	119	59	48	74	

Table 11. Shannon-Wiener diversity index, Simpson's diversity index and species number.

County	Simpson's diversity index	Species number	Shannon-Wiener Index
Harsin	0.15	10	2.07
Javanroud	0.12	9	2.14
Kangavar	0.17	11	2.07
Sarpole zohab	0.3	11	1.67
Songhor	0.17	13	2.16
Eslamabade gharb	0.15	19	0.52
Sahne	0.13	19	2.43
Kermanshah	0.13	29	2.41

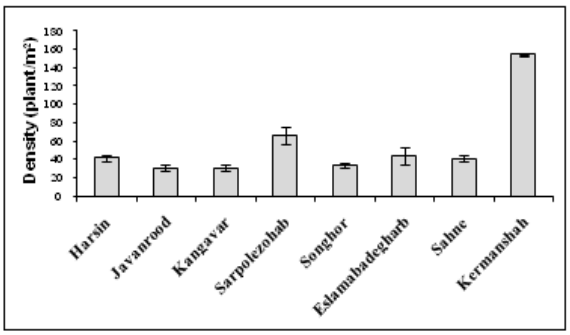

Fig. 4. Density of Weeds in barley fields of Kermanshah province.

Sarpolezohab County has a significant difference in weed diversity with the other counties (except Kangavar county) (Table10).

Comparisons performed by t-test showed that Eslamabade gharb County has a significant difference in weed diversity with the Songhor county (Table 10).

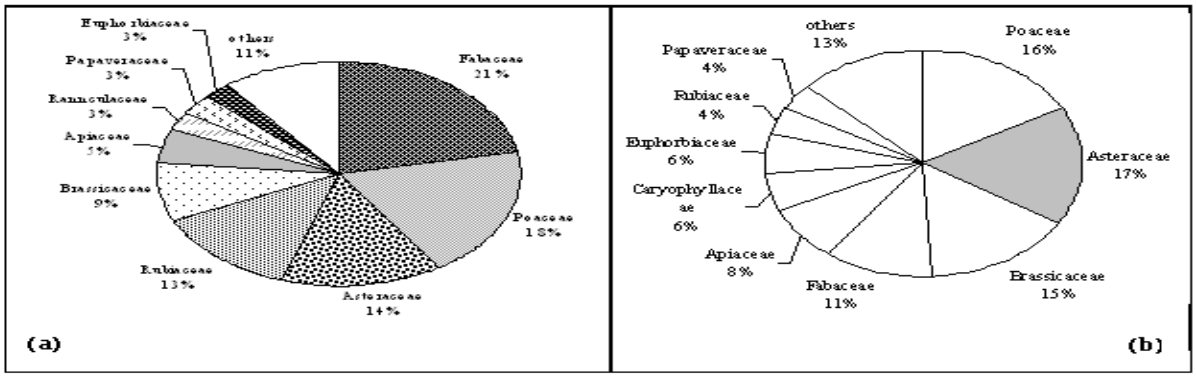

Fig. 5. (a) Grouping of plant families based on FIV index (b) Percentage of weeds in plant families in barley of Kermanshah province.

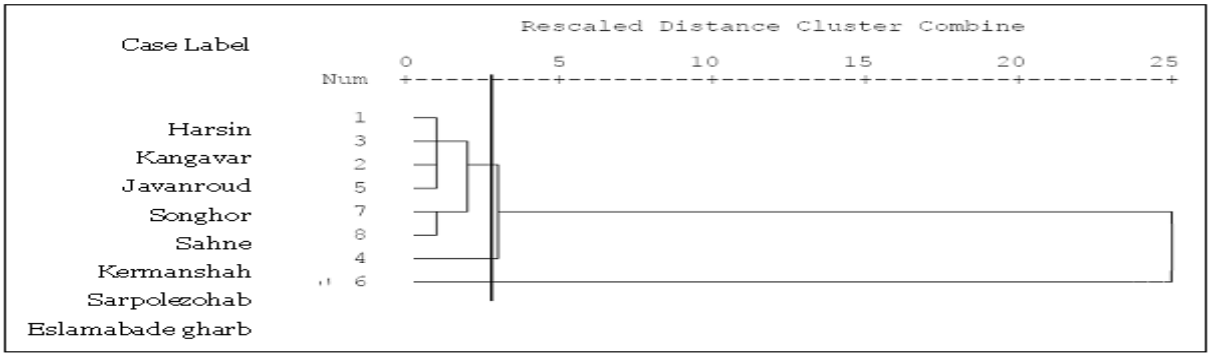

Fig. 6. Cluster analysis of diversity by Shannon-Wiener Index in 8 counties of Kermanshah province.

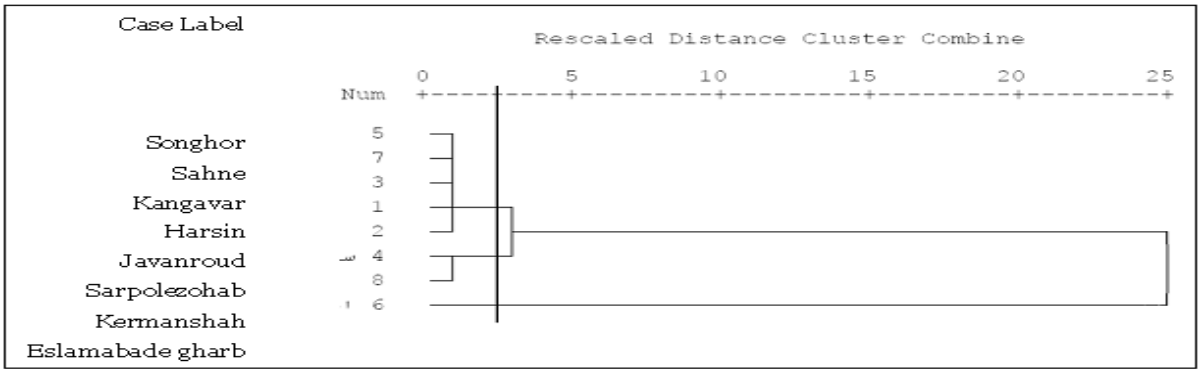

Fig. 7. Cluster analysis for uniformity of species in counties of Kermanshah province.

Conclusion

In general, with respect to the identification, population and distribution of weed species in barley fields and using suitable weed management can reduce the amount of interfering species problem. In fields, that were continuously cultivated wheat and barley, wild barely (*Hordeum spontaneum*) population was high. Licorice is due to be permanent, not controlled by the barley herbicide and was found in fields that are more fertile soil. Abundant population of wild oats (*Avena ludoviciana*) due to increased weed resistance to herbicides is Clodinafop Propargyl. 2,000 hectares of cereal fields in Kermanshah province are infected to wild oat resistant Clodinafop Propargyl (Gherekhloo and Zand, 2010).

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