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Weed species diversity and population indices in irrigated and rain-fed chickpea (*Cicer arietinum* L.)

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Key words: Abundance index, Frequency, Mean density, Rain-fed, Uniformity.

Abstract

This study was conducted to evaluate the species diversity and population indices of weeds in irrigated and rain-fed chickpea (*Cicerarietinum* L.) fieldsof Kermanshah Iran, in 2014.The irrigated, spring and winter rain-fed fields of chickpea were selected for sampling of weed species population. The field surveys were made during the chickpea flowering stage. The weeds in 0.25 m^2quadrats were harvested and the frequencyindex, uniformity, density, averagedensityandabundance indexwas calculated.The results showed that in irrigatedchickpea fields thejohnsongrass(*Sorghum halepense*(L.) Pers.)andlambsquarters (*Chenopodium album*L.) had the highest frequency, uniformity, density and abundance index.In the winter rain-fed chickpea the common hedge parsley (*Torilisarvensis* (Huds) and wild oat (*Avenaludoviciana*Durieu.) and inthe spring rain-fed chickpea the common liquorice(*Glycyrrhizaglabra*L.) and *Torilisarvensis*(Huds) had the highest frequency, uniformity, density and abundance index. Generally we can conclude that the cropping system could affect the weed species diversity and composition.

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Introduction

Because the adverse effects on crop yields, weed has long been known as a component of agricultural ecosystems and one of the main factors reducing the crop yield (Schroeder *et al*., 2006).An important feature of legume crop is atmospheric nitrogen fixing resulted in soil fertility for subsequent crops (mainly wheat) (Doucet*et al*., 1999; Amini*et al.,* 2013a, 2013b). Weed species affect cropgrowth and yield by allelopathy (Amini*et al.,* 2009; Amini and Namdari, 2013) or competition for limited resources (Amini*et al*., 2014; Amini*et al.,* 2013b, 2013c,).The global yield loss due to the weeds is 15% of achievable production of 10 main food crops. Also the economic damage in developing countries is more than developed countries (Kuchake*et al*., 2006).

Chickpea (*Cicerarientinum* L.) is one of the cultivated crops of legume family, the most important pulse crop in developing countries, so that 92% of the cultivated area and 88% of its production is belonging to these countries (FAO, 2013).Iran with a cultivated area of about 700 hectares ranked fourth in the world after India, Pakistan and Turkey.In Iran the average grain yield of chickpea per unit area is400 kg/ha that is very low compared to the global average (Parsa and Bagheri, 2008). This crop has been cultivated mainly as winter crop in rain-fedor dryland farming system and this crop has low competitive ability against the weeds and weed control is essential for its production (Wilson and Lyon, 2005).

Weed distribution and their competitive ability could affect their damage in the agriculture. Information about the distribution patterns of weeds in a region could help us for selecting the best weed management method and therefore reduce the herbicide application in the agricultural ecosystems and also increase the herbicide efficacy for weed control (Adim, *et al.,*2010).Dzyanyan (1996), evaluated the weed flora of Semnanprovince and the weed species with high frequency and density were Russianknapweed (*Acroptilonrepense* L.), *Alhajipersarum*Boss., wild oat (*Avenafatua* L.), slender meadow foxtail (*Alopecurusmyosuroides* Huds.), hoary cress (*Cardariadraba* L.), field bindweed (*Convolvulus arvensis*L.),littleseed canarygrass (*Phalaris minor*Retz.) Russian knapweed (*Acroptilonrepens* L.) and rye (*Secale cereal* L.).Adim*et al.* (2010) also surveyed the distribution and demographic characteristics of weed species in wheat fields in Sistan-Baluchistan province and the results showed that Japanese chess (*Bromus japonicas*Thunb ex murray), winter wild oat (*Avenaludoviciana* L. Dur.) and littleseed canarygrass(*Phalaris minor* Retz.) were the dominant narrow leaves weeds, respectively.The annual yellow sweetclover(*Melilotusindicus* (L.) All.), dwarf mallow (*Malvaneglecta* Wall.) and prostrate knotweed (*Polygonumaviculare* L.) were the dominant broad-leaf weed species in irrigated wheat fields in Sistan and Baluchestan,respectively. Also the weed speciesin wheat maturity stage prior harvesting operation were including hoary cress(*Cardariadraba* (L.) Desv.), field bindweed (*Convolvulus arvensis* L.),*Alhagipseudalhagi*, (M .Bieb.)Desv.)andsaltwort (*Salsola*spp.). Thomas (1985) has developed a weed distribution map in different crops and determines the relative frequency, relative uniformity and relative density for different weed species and evaluated the various aspects of weed distribution in different crops for four years in Saskatchewan (Canada).

Thomas and Dale (1991) evaluated the adaptabilityof weed species to variation of climatic conditions and concluded that two important components including rainfall and temperature determine the distribution patterns of weed species. In another study Schroeder *et al.*(1993) determined the abundance and distribution of the most important weeds in the main crops of 26 European countries and also presented thedistribution pattern of someherbicide resistantweed biotypes.The cropping systems could affect the weed distribution and population. Therefore the purpose of this studyisevaluating the weed species diversity and population indices of weeds in irrigated and rain-fed (spring and winter planting) chickpea fieldsof Kermanshah, Iran.

Materials and methods

Description of survey area

The irrigated and rain-fed spring and winter chickpea fields in Ravansarcity (34°42′55″N 46°39′12″E) in the northwest of Kermanshah Province Iran was selected in 2014. The 150fields were selected for weed sampling.

Weed sampling procedure

After choosing the field, the researcher followed a "w"-designated set pattern for sampling theweeds in each type of field.The pattern and number of0.25 m² quadrats varied according to the size of the chickpea fields. The weed samplingwas made during the chickpea flowering to pod filling stages. This period was chosen because of the easy identification of weed species at thisstage and the most infestation by weed occurs in this stages.

Measurements and data analysis

The frequency, uniformity, density, mean field density andabundance indexof weed species were calculated by following equations (Nkoa*et al.,* 2015):

The frequency (F) indicates the percentage of fieldsinfested by a weed species and is an estimate of the extent of the weed infestation in the surveyed area:

$$F_k = \frac{\sum yi}{n} \times 100$$

whereF_k is the frequency value for species k, Y_i is the presence (1) or absence (0) of species k in field i, and n is the number of fields surveyed.

The uniformity (U) indicates the percentage of quadratsinfested by a weed species and is an estimate of the area infestedby a weed species:

$$Uk = \frac{\sum_1^n \sum_1^m Xij}{\sum_1^m mi}$$

Where U_k is the field uniformity value for species k,X_{ij} isthe presence (1) or absence (0) of species k in quadrat jin field i, and m is the number of quadrats / field.

The density (D) indicatesthe number of individuals of aspecies per m²:

$$D_{ki} = \frac{\sum_1^m Zj}{m} \times 4$$

where$D_{ki}$is the density (expressed as number per m²) valueof species k in field i and Z_j is the number of plants inquadrat j.

The mean field density (MFD_{ki}) indicates the number ofplants per m² and was used to indicate the infestation in all the surveyed chickpea fields. The mean fielddensity was calculated by adding each field density(D) and dividing it by the total number of surveyed fields (n):

$$MFD_{ki} = \frac{\sum_1^n Dki}{n}$$

The abundance index (AI) of each species was calculated as follows. For species k:

$AI_K= F_k+U_k+MDF_k$

AI_k is theabundance index of weed species K.

Results and discussion

Weed species of irrigated chickpea

The results showed that in irrigated chickpea fields among the weed speciesthe (*Sorghum halepense*) had the highest frequency, uniformity, mean field density and abundance index and (*Chenopodium album*) was the second (Table 1). The *Amaranthusretroflexus, Avena fatua* , *Torilisarvensis* and *Glycyrrhiza glabra* had the lowest frequency. The lowest uniformity, mean field density (MDF) and abundance index was allocated to the *Glycyrrhiza glabra*among the weed species.

Evaluating the life form of weed species of irrigated chickpea field showed that the perennial dicotyledonous weeds had the highest percentage (44.44%) and the annual and perennial monocots had the lowest percentage (11.11%) among the life forms (Figure 1). The perennial dicotyledonous consisted of 33.33% of life forms.

Weed species of rain-fed winter chickpea

In the rain-fed winter chickpea fieldsamong the weed speciesthe *Torilisarvensis* and *Avena ludoviciana* had the highest frequency (100%) and the *Torilisarvensis* had the highest uniformity, mean field density and abundance index (Table 2).Among the weed species the*Hordeum murinum*and *Convolvulus arvensis*indicated the lowest frequency (33.33%) and the *Convolvulus arvensis*showed the lowest uniformity, mean field density and abundance index.

Table 1. The frequency, uniformity, mean field density and abundance index of weed species collected from irrigated chickpea fields in Ravansarcounty, Kermanshah, Iran.

No.	Weed species	Family	Life cycle	F (%)	U (%)	MFD (P/m²)	AI_k
1	*Sorghum halepense*	Poaceae	Perennial	100	86.66	6.93	193.60
2	*Chenopodium album*	Chenopodiaceae	Annual	66.66	66.66	5.33	138.66
3	*Polygonumaviculare*	Polygonaceae	Annual	66.66	33.33	1.60	101.59
4	*Convolvulus arvensis*	Convolvulaceae	Perennial	66.66	33.33	1.60	101.59
5	*Carthamusoxyacantha*	Asteraceae	Annual	66.66	26.66	1.06	94.39
6	*Amaranthusretroflexus*	Amaranthaceae	Annual	33.33	20.00	1.33	54.66
7	*Avena fatua*	Poaceae	Annual	33.33	20.00	0.80	54.13
8	*Torilisarvensis*	Apiaceae	Annual	33.33	13.33	0.533	47.12
9	*Glycyrrhiza glabra*	Fabaceae	Perennial	33.33	6.66	0.26	40.26

Table 2. The frequency, uniformity, mean field density and abundance index of weed species collected fromrain-fed winter chickpea fields in Ravansarcounty, Kermanshah, Iran.

No.	Weed species	Family	Life cycle	F (%)	U (%)	MFD (P/m²)	AI_k
1	*Torilisarvensis*	Apiaceae	Annual	100	73.33	14.40	187.73
2	*Avena ludoviciana*	Poaceae	Annual	100	40.00	6.40	146.40
3	*Lathyrussativus*	Fabaceae	Annual	66.66	33.33	1.60	101.60
4	*Glycyrrhiza glabra*	Fabaceae	Perennial	66.66	20.00	1.86	88.53
5	*Polygonumaviculare*	Polygonaceae	Annual	66.66	20.00	1.33	87.10
6	*Lathyrusaphaca*	Fabaceae	Annual	66.66	20.00	0.80	87.47
7	*Apocynumvenetum*	Apocynaceae	Annual	66.66	13.33	1.06	81.06
8	*Hordeum murinum*	Poaceae	Annual	33.33	20.00	1.33	54.67
9	*Convolvulus arvensis*	Convolvulaceae	Perennial	33.33	13.33	0.53	47.12

The results for the life form of weed speciesof rain-fed winter chickpea fieldsindicated that the perennial dicotyledonous, annual dicotyledonous and annual monocots had the same proportion (33.33%) in the chickpea fields (Figure 2).

Weed species of rain-fed spring chickpea

The population indices of weed species in the rain-fed spring chickpea showed that among the weed speciesGlycyrrhiza glabra*had the highest frequency, uniformity, mean field density and abundance index and the *Torilisarvensis*was the second in ranking. *The Cirsiumarvense and Lathyrusaphaca*had the lowest frequency, uniformity, mean field density and abundance index among the weed species.

The life form of weed species in rain-fed springchickpea fields showed that the perennial dicotyledonous and annual dicotyledonous had the same and highest proportion (42.85%) among the life forms. Also the annual monocots had the lowest proportion (14.28%) among the life forms (Figure 3).

Table 3. The frequency, uniformity, mean field density and abundance index of weed species collected fromrain-fed springchickpea fields in Ravansarcounty, Kermanshah, Iran.

No.	Weed species	Family	Life cycle	F (%)	U (%)	MFD (P/m^2)	AI_k
1	*Glycyrrhiza glabra*	Fabaceae	Perennial	100	76.00	4.48	180.48
2	*Torilisarvensis*	Apiaceae	Annual	80.00	60.00	3.36	143.36
3	*Convolvulus arvensis*	Convolvulaceae	Perennial	80.00	48.00	2.88	130.88
4	*Carthamusxyacantha*	Asteraceae	Annual	80.00	48.00	2.88	130.88
5	*Avena fatua*	Poaceae	Annual	40.00	36.00	1.76	77.76
6	*Cirsium arvense*	Asteraceae	Perennial	20.00	8.00	0.32	28.32
7	*Lathyrusaphaca*	Fabaceae	Annual	20.00	8.00	0.32	28.32

Based on the results of this study, the total number of broadleaf weed species was higher than that of narrow-leaf weed species. Thecrop rotation and application of herbicides can also lead to changes in the seed bank of weed seeds in the field soil (Derksen*et al.,*2002; Davis *et al.,* 2005). Ahmadvand (2005) found that differences in tillage practice are one of the most important factors affecting the weed population structure. According to Hume (1987) herbicide application had more effects on weed density, species composition and weed flora in comparison with other weed management strategies. Derksen*et al.,* (2002) composition of weed flora in cropping systems is due to the seasonal changes, crop rotation, long-term environmental changes such as soil erosion and climate change.

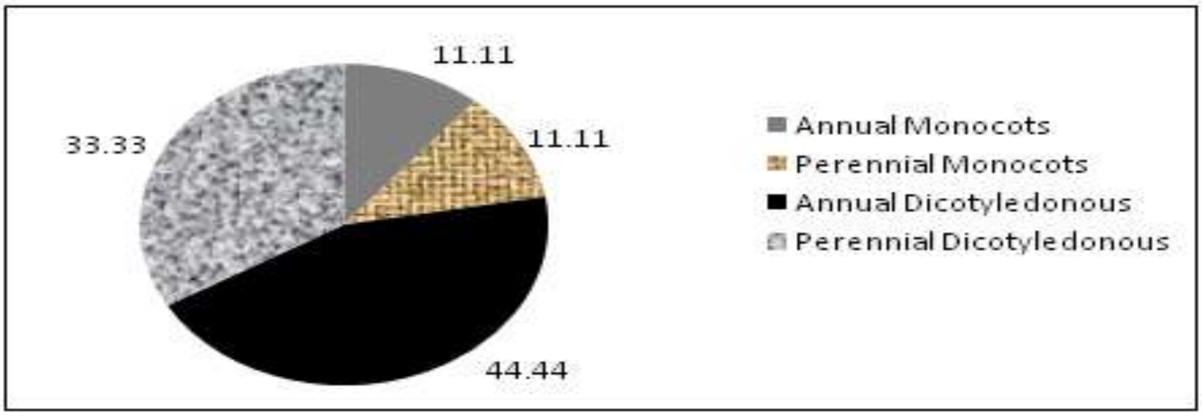

Fig. 1. The life form of weed species of irrigated chickpea field in Ravansarcounty, Kermanshah, Iran.

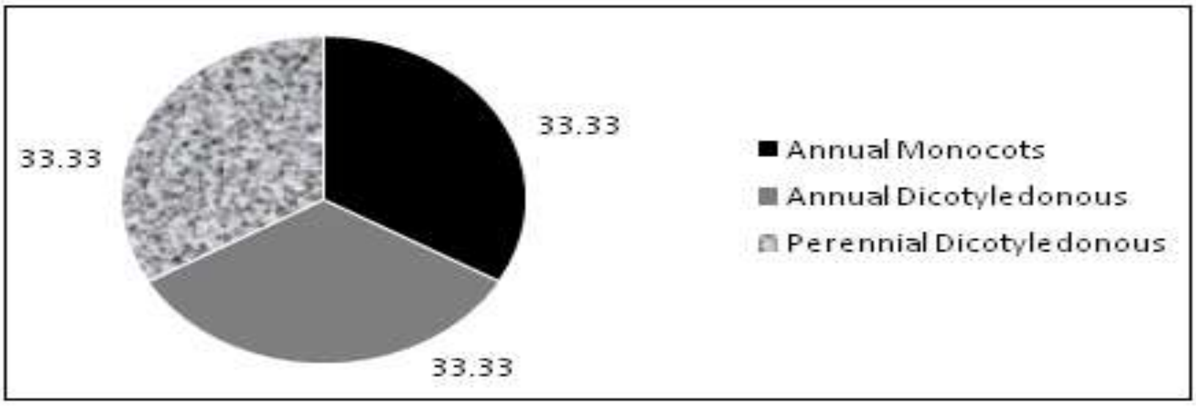

Fig. 2. The life form of weed species of rain-fed winter chickpea fields in Ravansarcounty, Kermanshah, Iran.

Some researchers believe that farming operations such as tillage systems, crop species, methods of weed control and fertilization can alter the normal pattern of distribution and access to resources and as a result of changes in adaptation of weed species in a way that leads to the removal of some species and the introduction of other species as a result of changes in the structure and composition of plant species (Poggio, 2005).The community structure and species diversity of weeds is determined as a result of environmental factors, management and interspecific competition between weeds and intra-specific competition between crops and weeds.

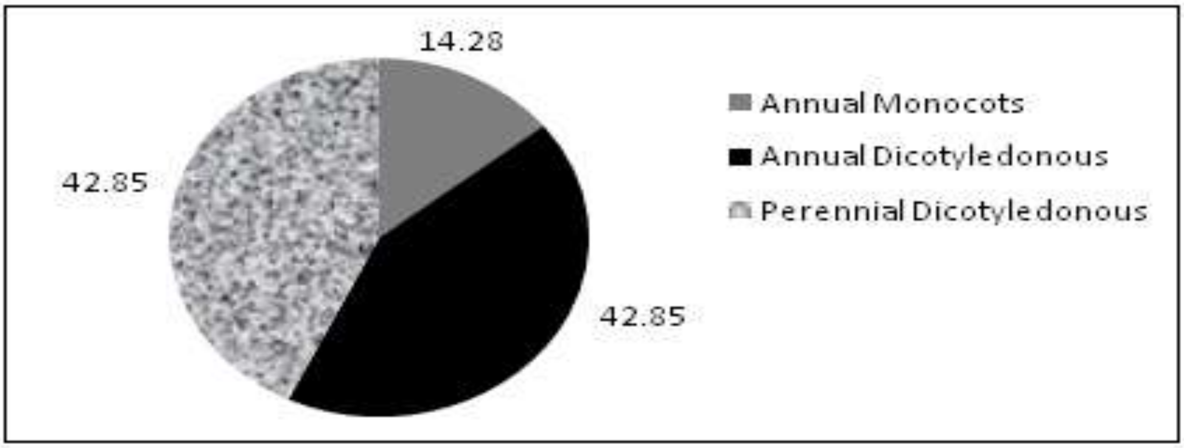

Fig. 3. The life form of weed species of rain-fed springchickpea fields inRavansarcounty, Kermanshah, Iran.

The variations in community structure of weed speciesis an indicator of successin weed management practices (Dutoit*et al.*, 2003). Changes in weed population to a few dominant species, indicating the provision of the necessary conditions for reconciliation is a common species in cultivation practices. Diversification in products and systems are able to crop production, as well as diversity of weeds and weed management systems can result in maximum efficiency in the use of materials is available in a cropping system (Dutoit*et al.*, 2003). Differences in population structure of weeds in wheat and chickpea due to the difference in weed management has been reported (Poggio*et al.,* 2004). Dale et al (1992) also observed that weed flora among fields, regions, climatic conditions and cropping systems was different. Menalled (2001) observed differences in plant species due to the effect of tillage, fertilizer; herbicides and other methods of weed management. Lair (2004) reported that the continuous use of herbicides with the same mechanism of action led to changes in weed population of herbicide-resistant weed species.

Conclusion

Generally we conclude that the farming system of chick pea could affect the weed species diversity and population structure. As we observed that in irrigated chickpea fields the summer perennial and annual weeds such as *Sorghum halepense*and*Chenopodium album* had the highest abundance index.In the rain-fed winter chickpea the winter annual weed such as*Torilisarvensis*had the highest abundance index and perennial weed species such as*Convolvulus arvensis*had the lowest abundance index. In rain-fed spring chickpea the perennial weed *Glycyrrhiza glabra*had the highest abundance index and the winter annual weed *Lathyrusaphaca*had the lowest value. In other words in different chickpea cropping system the dominant weed species are different and therefore different weed management strategies should be developed to prevent crop yield loss.

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