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Distribution of dominant weed species in winter wheat at Tabriz county

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Abstract

Weed flora surveys were conducted to determine the distribution of dominant weed species in wheat (*Tirticum aestivum* L.) fields at Tabriz county. Only 3.91% of weeds were assertive and observed in more than 60% of fields, but 89.84% of weeds were found in less than 30% of fields. Assertive weeds were corresponding with 13 abundant weed species. These weeds were adapted to farmer's management methods. The major families for these noxious weeds were Chenopodiaceae, Brassicaceae, and Poaceae with 3, 2, and 2 dominant species, respectively. *Acroptilon repens* (L.) DC., *Eremopyrum Bonaepartis* (Spreng.) Nevski, and *Cardaria draba* (L.) Desv. with 114.1, 105.48, and 100.39 DI (dominance index) were dominant in winter wheat fields at Tabriz county. *A. repens* (L.) DC. and *C. draba* (L.) Desv. had highest relationship together. Also, highest correlation was observed between *Polygonum aviculare* L. and *Chenopodium album* L. These weeds were observed in more than 60% of fields. *E. Bonaepartis* (Spreng.) Nevski with mean density 3.26 plants m^{-2} had highest density, higher values of density shows that this weed has more competitive or reproductive ability than other weeds. And also, higher value of uniformity for *E. Bonaepartis* (Spreng.) Nevski represents that this weed is more compatible with the soil and climate conditions.

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Introduction

Weeds are constant component of agro-ecosystem that have harmful effects on crop quality and quantity (Powell and Justum, 1993). These plants are competitors to agricultural crops because of their high adaptability to different environmental conditions. These unwanted plants compete with crops for light, water and nutrients (Wang *et al.*, 2007). The yield losses due to weed crop competition mainly depend on kind of weed species, their density and cover percentage. Zand *et al.* (2007b) reported that weeds reduce wheat yield up to 30% in Iran. Chemical control is the most widely applied method of weed control in Iran (Zand *et al.*, 2007a, 2007b; Baghestani *et al.*, 2007a, 2007b). Farmers in our country traditionally use broadleaf herbicides tribenuron methyl and 2,4-D plus MCPA, and grass herbicides clodinafop propargyl and diclofop methyl (Zand *et al.*, 2007a). But in Tabriz county (north west of Iran), farmers mainly use 2,4-D plus MCPA for broadleaf weeds control. Frisbie *et al.* (1989) reported that weed distribution and infestation intensity is different, so the extent of crop yield reduction will mainly depend on the density and diversity of weeds in the field. Although, two weeds may be superficially very similar but they differ in their growth habit, reproductive, time of maximum competition and response to individual control methods (Memon *et al.*, 2013). So, identification of weed species is basement for their management. And also for an effective weed management program, we need to have accurate information on the systematic of weeds, their frequency, uniformity, density, coverage, growth habit, phenology (Ghersa and Holt, 1995; Hassannejad and Porheidar-Ghafarbi, 2012). Weed studies are useful for detecting relative importance of weed species in crop production systems (Thomas, 1985; McCully *et al.*, 1991). Weeds are one of the major limiting factors in Iranian wheat fields (Minbashi *et al.* 2008). Some studies about weed flora in cereal and oil seed crops have been done in some counties of Iran (Minbashi *et al.* 2008). But, we have a little information about distribution of dominant weeds in wheat fields at northwest of Iran. So, the objective of this study was to determine the dominant weed species and survey of their distribution in wheat fields at Tabriz county.

Materials and methods

Description of survey area

Tabriz county of Iran is located between 35º 7´ latitude and 46 º 26 longitudes. This county has cold semi-aried climates.The average annual precipitation is 289 mm. The annual mean temperature is 12.5○. The average annual sunshine hours are 2794.3. Wheat fields surveyed in this study lie between 1200 and 2000 m a.s.l.

Sampling procedure

The field surveys were made during the wheat tillering to stem elongation stages (Minbashi *et al.*, 2008). This sampling time was chosen because: a) most of the weeds were well established in this time; and b) identification of weed species was possible because these plants were in flowering or fruit setting stages and easily recognizable. Fields were surveyed following the methodology of Thomas (1985) in which 20 quadrates of 0.25 m² were randomly placed along a "W" pattern consisting of 5 quadrates in each one of 4 arms of the pattern, in each field.

Data analysis

Univariate Analysis

All weeds in each quadrate were identified, counted (density and cover percent), and recorded for subsequent data entry and analysis. All weed species observed in the field condition were classified in to three groups, including surpassing weeds (SW), underneath weeds (UW), and climbing weeds (CW).The surpassing weeds can be viewed and differentiated easily from distance during field survey (Memon, 2004). Competition ability of these weeds for sunlight is highlight. In order to distribution patterns, all weeds in wheat fields at Tabriz county were classified in to four categories; Assertive weeds (frequency over than 60%), ascendant weeds (frequency between 50% to 60%), average weeds (frequency between 30% to 49%), and below average weeds (frequency less than 30%)

(Mori *et al.*, 1983). The data recorded in each quadrate (density and cover percentage), all quadrates of each fields (uniformity), and all fields of this county (frequency) were summarized using some quantitative measures (frequency, uniformity, density as outlined by Thomas (1985) and cover percentage as outlined by Hassannejad and Porheidar-Ghafarbi (2012). The finale quantitative measure calculated was dominance index (DI) that introduced by Hassannejad and Porheidar-Ghafarbi (2012). This measure calculated from frequency, field uniformity, mean density, and mean cover percentage as follows.

The frequency (F) value was the percentage of fields infested by a species k, at least in one quadrate per field. This measure is an estimate of the geographical extent of the infestation in the province.

$$Fk = \frac{\sum_1^n Yi}{n} \times 100$$

Where Fk, is the frequency value of 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 field Uniformity (U) value indicates the percentage of quadrates (20 quadrates per field) infested by a species. This measure is an estimate of the area infested by a weed species.

$$Uk = \frac{\sum_1^n \sum_1^{20} Xij}{20n} \times 100$$

Where Uk, is the field uniformity value of species k, Xij is the presence (1) or absence (0) of species k in quadrate j in field i, and n is the number of fields surveyed.

The density (D) value was calculated as the mean number of plant per square meter for each weed species, expressed over all fields surveyed.

$$Dki = \frac{\sum Zj}{20} \times 4$$

Where Dki is the density (individuals per square meter) of species k in field i and Zj is the number of plants of each species in quadrate j (each quadrate is 0.25 m^2).

The mean field density (MFD) value indicates the number of plants per square meter for each species averaged over all fields sampled. This measure was used to magnitude of the infestation in all the surveyed fields.

$$MFDk = \frac{\sum_1^n Dki}{n}$$

Where $MFDk$ is the mean field density of species k, Dki is the density (numbers per square meter) of species k in field i, and n is the number of all fields surveyed.

The cover percentage (Cki) value indicates the vertical projection on the ground, based on visual estimates; it usually does not include overlaps. For visual estimates, some count "empty space" within a clump and others do not.

$$Cki = \frac{\sum Zj}{20}$$

Where Cki is the cover percentage of species k in field i, Zj is the cover percentage of species k in quadrate j.

The mean cover percentage (MCi) value indicates the cover of plants per square meter for each species averaged over all fields sampled.

$$MCki = \frac{\sum Cki}{n}$$

Where $MCki$ is the mean field cover k, Cki is the cover percentage of species k in field i, and n is the number of fields surveyed.

To summarize the dominance of a species, four of the above measures were combined in to a single value. The dominance index (DI) was calculated by assuming that the frequency, field uniformity, mean field density, and cover percentage measures were equally important in describing the importance of a weed species.

$$DI = F + U + MD + MC$$

Multivariate Analysis

Species presence (1) and absent (0) data were subjected to multivariate data analysis to detect differences between the weed communities of each district. One important advantage of a multivariate analysis approach is that it allows comparisons utilizing all occurring weed species as variables in the analysis (Derksen *et al.* 1993). After weed species were collected in the fields, we arranged the samples (fields) into matrix where weed species are represented by columns and fields of different districts by rows. The first component axis explains the greatest proportion of linear variation in the data, whereas the second axis explains the next greatest proportion of variation. Data on weed species of all districts were analyzed through with ordination methods like detrended correspondence analysis (DCA) and weed species distribution displayed in ordination diagrams. DCA were done with presence (1) and absent (0) data of 13 abundant weed species (species that observed in more than 30% of winter wheat fields at Tabriz county) using CANOCO (Version 4.5). Ordination plots were produced for both sampling fields and weed species associated. Districts and species that are close together in ordination space are more similar than those that are further apart, like Jongman *et al.* (1995) reported in their researches.

Results and discussion

Only 13 weed species were found in more than 30% of fields. These abundant weeds were belonging to Chenopodiaceae, Brassicaceae, and Poaceae with 3, 2, and 2 species, respectively. Between all recorded weeds, 89.84 of weeds were found in less than 30% of fields (below average weeds). 6.25% of weeds were found in 30-49% of fields (average weeds). Only 3.91% of weeds (5 species) were observed in more than 60% of fields (Assertive weeds). Higher values for the frequency of these weeds show a higher proportion of their Climatic and soil conditions, like that Minbashi *et al.* (2008) mentioned it in their researches. Eight species of 13 dominant weed species (frequency more than 30%) belong to surpassing weeds. These weeds had highest competition ability for sunlight (Table 1). Surpassing weeds were distributed in 1.12% to 70.05% of quadrates in wheat fields (Table 1). *Eremopyrum Bonaepartis* (Spreng.) Nevski had highest uniformity in distribution, because this weed was found in 70.05% of quadrates in each field. Ranking all weeds showed that *Acroptilon repens* (L.) DC., *Eremopyrum Bonaepartis* (Spreng.) Nevski, and *Cardaria draba* (L.) Desv. with dominance index (DI) equal 114.1, 105.48, and 100.39 were dominant weeds in winter wheat fields at Tabriz county (Table 1). Dominance of these weeds might be due to their better adaptability under environment conditions and farmers management methods. *E. Bonaepartis* (Spreng.) Nevski with mean density 2.08 plants m^{-2} had highest density in this county (Figure 1). Higher values for the mean field density for this weed species shows that this weed has more competitive or reproductive ability than other weeds. Lower values the frequency of *E. Bonaepartis* (Spreng.) Nevski represents that this weed is not compatible with the soil and climate conditions, like that Minbashi *et al.* (2008) mentioned that in their researches, but higher values the uniformity of this weed species indicate it's tolerant to managements methods used in the occurrence fields. Results of the present study showed that *E. Bonaepartis* (Spreng.) Nevski was more uniform in wheat fields of Tabriz county. But most of dominant weeds in wheat fields of this county were much less uniform (i.e., more patchy). Uniformity measurements provide an indication of weed patchiness (Ominski *et al.*, 1999).

Table 1. Scientific name, Habit, Weed Code, Frequency (F), Uniformity (U), Mean Density (MD), Mean Coverage percentage (MC), and Dominance Index (DI) of abundant weeds observed in more than 30% of winter wheat fields at Tabriz county.

No.	Weed species	Habit	Code	F	U	MD	MC	DI
1	Acroptilon repens (L.) DC.	SW	Acr.re	82.22	30.57	1.28	0.03	114.1
2	Eremopyrum Bonaepartis (Spreng.) Nevski	UW	Ere.bo	33.33	70.05	2.08	0.02	105.48
3	Cardaria draba (L.) Desv.	SW	Car.dr	75.56	22.57	0.56	1.7	100.39
4	Polygonum aviculare L.	UW	Pol.av	64.44	29.02	0.83	0.53	94.83
5	Chenopodium album L.	SW	Che.al	62.22	21.48	0.88	1.15	85.73
6	Convolvulus arvensis L.	CW	Con.ar	64.44	18.79	0.62	1.58	85.43
7	Alopecurus myosuroides Hudson	SW	Alo.my	40	16.76	1.06	0.07	57.89
8	Alhagi persarum Boiss. & Buhse.	SW	Alh.pe	40	9.83	0.09	0.04	49.96
9	Fumria vaillantii L oise.	UW	Fum.va	42.22	6.31	0.3	0.57	49.40
10	Adonis aestivalis L.	UW	Ado.ae	31.11	6.45	0.07	2.88	40.51
11	Salsola kali L.	SW	Sal.ka	33.33	6.55	0.34	0.28	40.50
12	Goldbachia laevigata	SW	Gol.la	31.11	6.79	0.23	0.61	38.74
13	Kochia scoparia (L.) Schrad.	SW	Koc.sc	35.56	1.12	0.05	0.14	36.86

Table 2. Eigenvalues of DCA axes that explained of the variation in weed species distribution.

Axes	1	2	3	4
Eigenvalues	0.258	0.152	0.112	0.086
Lengths of gradient	2.621	3.219	1.793	1.651
Cumulative percentage variance of species data	23.2	36.9	46.9	54.7

The results of DCA for only 13 abundant weed species clearly demonstrated the relationships between weed species distribution and their sampling fields. The first two DCA axes explained 36.9% of the variation in weed species distribution at Tabriz county (Table 2). Analysis with DCA classified these weeds in two main groups. In the first group, *Acroptilon repens* (L.) DC. and *Cardaria draba* (L.) Desv. were located (Table 2). These two weeds were found in maximum number of surveyed fields (Table 1 and Figure 3). Higher values for frequency of these two weeds indicate their versatility to soil, climate and management methods. In the second group, *Polygonum aviculare* L. and *Chenopodium album* L. had highest relationship together (Figure 2), so that they were found in 64.44 and 62.22% of fields (Table 1). By increasing distance between weed species in DCA biplot, the correlation between them were decreased (Figure 2). *A. repens* (L.) DC., *C. draba* (L.) Desv., *P. aviculare* L., and *C. album* L. had highest correlation together and with sampling fields, so that these weeds were found behind most of the fields (Fig. 3).

Results of this study showed highest richness and diversity in weed population, and lowest number of dominant weeds in wheat fields. This is may be due to versatility of these dominant weeds to management methods applied in these fields. Scientists believe that the ecological and management status could be responsible for weed density, diversity and their dominance (Dale *et al.* 1992; Salonen 1993; Clements *et al.* 1994; Stevenson *et al.* 1997; Anderson and Milberg 1998; Buhler 1988; Doucet *et al.* 1999; Hyvönen *et al.* 2003; Marshall *et al.* 2003; Murphy and Demerle 2006;

Andreasen and Stryhn 2008; Andreasen and Skovgard 2009).

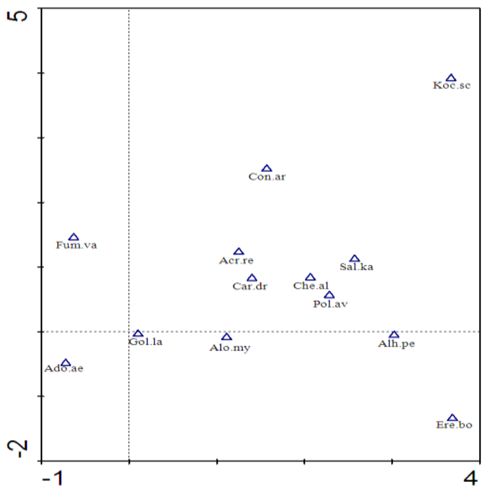

Fig. 1. Mean density of 13 abundant weed species observed in wheat fields at Tabriz county.

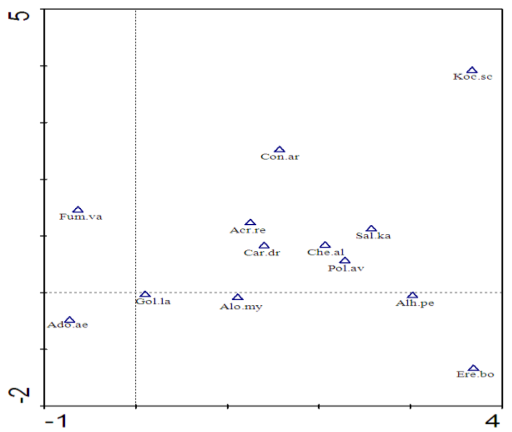

Fig. 2. Biplot for describing the relationship of weed species (occurring in 30% of fields) in wheat fields at Tabriz county. See Table 1 for a description of codes for each weed species.

Investigations showed that in many parts of this county, farmers don't attention to herbicides usage in management programs, or their information about these products is not sufficient. The data clearly indicate that herbicides like 2,4-D+MCPA used by Tabriz farmers were not effective against these five most abundant weeds in Table 1.

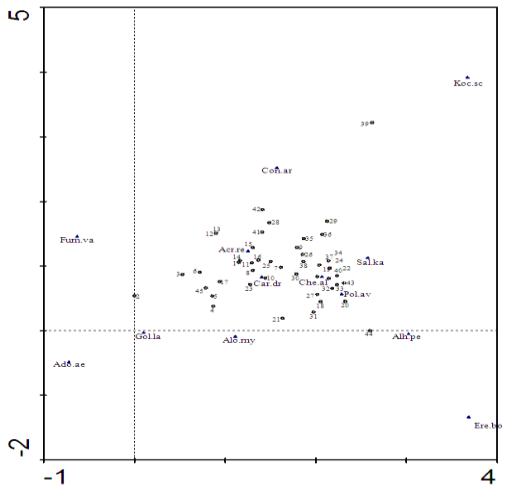

Fig. 3. Biplot for describing the relationship between weed species (occurring in 30% of fields) and their sampling sites at Tabriz county. See Table 1 for a description of codes for each weed species.

For example, the highest amount of dicotyledonous in this county indicated that herbicides like 2,4-D+MCPA are not used exactly. On the other hands, dominant weeds such as *A. repen* (L.) DC. and *P. aviculare* L. are weeds that have tolerant to 2,4-D+MCPA. After the activity of the 2,4-D+MCPA has decreased, *C. arvensis* L. grows quickly. Species like *C. album* L. that are known to be susceptible to MCPA and 2,4-D (Thomas *et al.*, 1994) were also found in 62.22% of wheat fields in Tabriz county, at 21.48 of sampling quadrates, with mean density of 0.88 plants m^2, and dominance index 85.73. Also, presence of this weed may be due to maximum application of nitrogen fertilizers in the wheat fields of this county. Because this weed is one of the nitrophilous plants that benefit of nitrogen fertilizers (Holm *et al.*, 1977). On the other hand, weed distribution may be the results of ecological reactions to soil characteristics of the site and the regional climate conditions. Investigations showed that weed species composition, population density, and their distributions can be change from place to place over time (Dale *et al.* 1992; Salonen 1993; Clements *et al.* 1994; Stevenson *et al.* 1997; Anderson and Milberg 1998; Buhler 1988; Doucet *et al.* 1999; Hyvönen *et al.* 2003; Marshall *et al.* 2003; Murphy and Demerle 2006; Andreasen and Stryhn 2008; Andreasen and Skovgard 2009).

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