Pak. J. Bot., 35(2): 155-160, 2003.

INVASIVE WEED SPECIES IN ONION PRODUCTION SYSTEMS DURING THE LAST 25 YEARS IN AMASYA, TURKEY

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Abstract

Many weed species are introduced in new region by accident and some of them become component of natural flora. In order to introduce invasive weed species and influence of agricultural practices on weed flora, the results of two surveys, which were performed in 1976 and 1999-2000 in Amasya province, were compared. As 23 weed species were recorded in the first survey, 87 weed species were identified in the second survey. According to the density, the most common species in the first survey were *Chenopodium album*, *Amaranthus retroflexus*, *Convolvulus arvensis*, *Heliotropium europaeum* and *Solanum nigrum*. In the second survey, it was found that *Xanthium strumarium*, *Cirsium arvense*, *Sinapis arvensis*, *Galium aparine* and *Bifora radians* have gained more importance over a period of 25 years. It was assumed that use of the same weed control methods, rotations, contaminated crop seed and fertilizing greatly altered weed species composition.

Introduction

Weeds are constant component of agro-ecosystem and alternative control methods have been used to control them in different crops (Powell & Justum, 1993). However many seeds of exotic species are introduced in new regions by accident and some of them may settle and become component of the natural flora (Jauzein, 1998; Maillet & Lopez-Garcia, 2000).

Density of single or many weed species can be changed depending on some factors during a long period. Purification of seed, choice of crops, rotations, sowing time and techniques, soil management, harvest time, fertilizing, chemical and mechanical weed control methods are the main factors that influence weed flora (Albrecht, 1995; Froud-Williams, 1987). It is often difficult to separate the effects of one factor from another due to reciprocal interactions between all these factors. But, using herbicides, rotations and fertilizing may take into consideration dominant factor responsible for changing in weed flora (Chancellor, 1985).

As in many crops, weeds cause certain yield reduction in onion owing to slow emergence, low initial growth rate, long vegetative period and low competitive ability (Prado *et al*., 1990; Dunan *et al*., 1996). For this reason, onion requires absolute early weed control. Until the late 1970, weed control in onion involved only manual and mechanical methods in Turkey. After this period chemical weed control and other technological agricultural practices were intensively used. The aim of this study was to record new introduced invasive weed species and to reveal the influence of agricultural practices on weed flora by comparing the results of surveys conducted in onion fields in Amasya province in 1976 and in 1999-2000.

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Material and Methods

The first survey was carried out in 1976 by Korkut and Kasa in Amasya province, while the second survey was conducted by Mennan in 1999 and 2000 using the same method described by Korkut & Kasa (1976) at same stage of onion growth; 17 fields were sampled in 1976 while 54 and 58 fields were sampled in 1999 and 2000, respectively.

The fields were randomly selected and sampling procedure was made depending on field size. The number of frames (1 m^{-2}) thrown in a field varied depending on field size; 5 times for 1-5 da^{-1}, 8 times for 5-10 da^{-1}, 16 times for 10-15 da^{-1}, 20 times for >15 da^{-1}. Weed species in each frame were recorded and counted. In order to eliminate the influence of field edge on survey sampling was made inside of the fields. In addition to that frequency and density of each weed species were calculated according to Odum (1971).

$$\text{Frequency (\%)} = 100 \times \frac{\text{Number of surveyed areas where a species occurred}}{\text{Number of total surveyed areas}}$$

$$\text{Density (plants/m}^{-2}\text{)} = \frac{\text{Total number of each species}}{\text{Total surveyed area}}$$

Some agricultural characteristics of the first (1976) and second surveys (1999-2000) in onion production are given Table 1. Similarity index between two surveys were calculated by using SI = 2C/(A+B) equation (Odum, 1971) where:

SI: Similarity index
A: Number of weed species in the first survey
B: Number of weed species in the second survey
C: Number of similar weed species in both surveys

The weed species were identified by using Flora of Turkey (Davis, 1965-1989).

Table 1. Some agricultural characteristics of two surveys in onion production

Agricultural practices	Survey in 1976	Survey in 1999-2000
Sowing area	6.630 ha	23.567 ha
Sowing type	by hand	by machine
Tillage	Animal drawn plough	Different implements
Herbicides application	No	2-3 different herbicides used in growing season
Fertilizing	No	DAP, (NPK)
Rotation	Wheat, onion	Wheat, onion, Sugar beet, barley
Harvest type	by hand	by machine
Mean yield	1.966 kg ha^{-1}	13.301 kg ha^{-1}

Table 2. Weed species having more than 5% frequencies and their densities in the first and the second surveys.

Weed species	First survey (1976)		Second survey 1999-2000	
	Frequency (%)	Density (plant m^{-2})	Frequency (%)	Density (plant m^{-2})
Chenopodium album	76.47	18.87	48.21	3.13
Convolvulus arvensis	58.82	5.03	91.07	6.16
Solanum nigrum	47.08	1.15	23.21	0.61
Amaranthus retroflexus	47.08	9.03	78.57	2.18
Heliotropium europium	35.29	3.55	13.39	0.23
Xanthium strumarium	35.29	0.80	83.03	4.11
Sonchus oleraceaus	35.29	0.70	5.35	0.06
Medicago sativa	35.29	0.54	14.28	0.19
Seteria spp.,	29.41	2.18	26.78	0.54
Cuscuta spp.,	29.41	0.87	2.68	0.00
Lithospermum arvense	23.52	1.71	10.71	0.05
Cirsium arvense	23.52	0.87	64.28	3.17
Galium aparine	23.52	0.77	67.85	3.17
Avena spp.,	23.52	0.49	22.33	1.24
Sinapis arvensis	23.52	0.13	66.07	2.63
Stelleria media	17.64	0.94	1.78	0.00
Polygonum convolvulus	17.64	0.32	16.96	0.20
Ranunculus repens	17.64	0.18	2.67	0.02
Polygonum aviculare	11.76	0.35	16.07	0.20
Euphorbia spp.,	11.76	0.11	16.96	0.10
Veronica persica	5.88	0.42	13.39	0.12
Sorghum halepense	5.88	0.14	18.75	0.69
Senecio vulgaris	5.88	0.04	8.92	0.02
Bifora radians	-	-	57.14	2.94
Tribulus terrestris	-	-	38.39	0.93
Echinochloa crus-galli	-	-	35.71	0.73
Cynodon dactylon	-	-	32.14	0.52
Malva neglecta	-	-	27.67	0.43
Alopecurus myosuroides	-	-	24.10	1.02
Vicia sativa	-	-	22.32	0.39
Portaluca olerecea	-	-	20.53	0.53
Matricaria chamomilla	-	-	17.85	0.35
Cyperus rotundus	-	-	17.85	0.40
Erinygium spp.,	-	-	16.96	0.18
Lathrus aphaca	-	-	16.96	0.13
Hibiscus trionum	-	-	16.07	0.21
Datura stromonium	-	-	13.39	0.08
Plantago media	-	-	13.39	0.08
Equisetum arvense	-	-	12.50	0.16
Prosopis stephanie	-	-	11.60	0.25
Anthemis arvensis	-	-	9.82	0.12
Melilotus officinalis	-	-	9.82	0.12
Fumaria officinalis	-	-	8.03	0.07
Taraxacum officinale	-	-	8.03	0.02
Ranunculus arvensis	-	-	6.25	0.08
Mercurialis annua	-	-	5.35	0.03

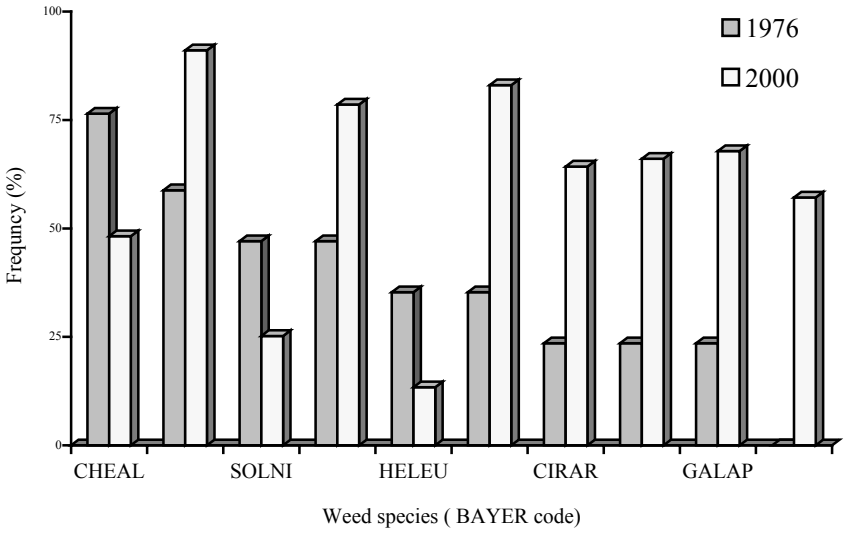

Fig. 1. Changes in frequencies of some common weed species in onion fields from 1976 to 1999-2000.

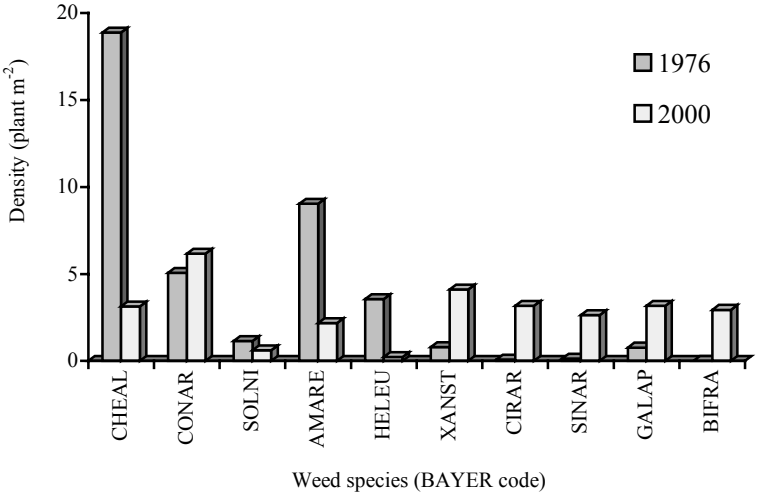

Fig 2. Changes in densities of some common weed species in onion fields from 1976 to 1999-2000.

Results

The number of weed species was found absolutely different in both surveys. A total of 23 weed species were recorded in the first survey, whereas 87 weed species were identified in the second survey (Table 2). In both the surveys some weed species couldn't be recognized at species level. The species having 5% frequencies were taken into consideration and it was found that frequencies and densities of some weed species changed in the last decade.

The frequencies of *Chenopodium album*, *Solanum nigrum* and *Heliotropium europium* were dramatically decreased. In contrast, frequencies of *Convolvulus arvensis*, *Amaranthus retroflexus*, *Xanthium strumarium*, *Cirsium arvense*, *Sinapis arvensis*, *Galium aparine* and *Bifora radians* showed an increased (Fig. 1).

Weed density is other way to explain changes in weed flora in a certain area. Use of the same weed control methods greatly altered species composition. According to the density, the most common species in the first survey were *Chenopodium album*, *Amaranthus retroflexus*, *Convolvulus arvensis*, *Heliotropium europaeum* and *Solanum nigrum*. In the second survey, it was very clear that *Xanthium strumarium*, *Cirsium arvense*, *Sinapis arvensis*, *Galium aparine* and *Bifora radians* gained more importance over a period of 25 years (Fig. 2).

Discussion

Density and composition of weed floras are strongly affected by crop production systems and agricultural practices. The use of herbicides with similar modes of action in this area has greatly altered the density of some species. Weed similarity index between two surveys was low 0.41. After the late 1970's, Linuron, Pyrazon and Monolinuron were used very intensively in onion fields. These herbicides had good effect on *C. album*, *S. nigrum* and some other dicotyledonous weeds. As a result of chemical treatments there was a decline in densities of these species. As seen in Table 2, the densities of *C. album*, *S. nigrum*, *A. retroflexus* and *H.europaeum* were decreased from 18.87 to 3.13 plants m^{-2}, from 1.15 to 0.61 plants m^{-2}, from 9.03 to 2.18 plants m^{-2}, from 3.55 to 0.23 plants m^{-2} respectively. Meanwhile, non-susceptible broad-leaved weeds against these herbicides and grass weeds have increased year by year. Some effective herbicides such as Pendimethalin and Oxyflorfen have been used since early 1990's. These herbicides controlled successfully some broad-leaved and grass weeds. But, vegetative reproducing weed species such as *C. arvensis* and *C. arvense* were not controlled and gained more importance. Similarly, many scientists found that use of herbicides was main reason for changing flora in cultivated lands (Chancellor & Froud-Williams, 1986; Streibig & Andreasen, 1993; Gönen & Uygur, 1998).

Other main factors changing in weed flora were rotation and contaminated crop seeds in this area. Onion was mainly rotated with wheat in this region. Wheat seeds were generally contaminated with the seeds of *B. radians*, *G. aparine*, *C. arvense* and *Avena* spp. These species germinate in both autumn and spring in this region. Therefore, these species occur in early stage of onion and cause important yield losses. Apparently, *G. aparine* will be the most important problem in onion fields by the time similar to situation in some European countries (Chancellor & Froud-Williams, 1986; Marshall, 1989).

Fertilizing has a great effect on the composition of weed flora (Andersson & Milberg, 1998). Density and frequency of weed species can be raised as a result of nitrogen fertilization, which directly, stimulate germination and reproduction. Application of fertilizer (NPK) encouraged nitrophilous species such as *G. aparine*, *E. crus-galli* and *A. myosuroides* (Ellenberg, 1979; Froud-Williams, 1987). Our results shown in Table 2 were similar to the results of previous studies. Irrigation may also influence weed floral composition. *Cyperus* spp., *S. halepense* and *E. crus-galli* could be more problems in future after began irrigation since 1978. Parker (1997) indicated that these species could be spread by irrigation.

It is not possible to distinguish single factor from another in floral changes. Also environmental factors should be taken into consideration in composition of weed species as well as agricultural practices.

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(Received for publication 25 June 2002)