Evaluation of weed flora and biodiversity indices in saffron fields (case study: Khorasan province)

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Abstract

Dynamics of weed populations in saffron fields are influenced by environmental and soil criteria and also by management practices. To assess weed flora and calculate biodiversity indices in saffron fields of Khorasan province, a survey trial was done in 50 fields during 2014 and 2015. Weed samplings were performed in vegetative growth, dormant and flowering stages of saffron randomly dropped based on systematic method as W pattern. Biodiversity indices were stability coefficient, Simpson, Shannon-Wiener, Margalef and Menhinick. Weeds were grouped based on four characters including vegetation form, photosynthetic pathway, vegetative cycle and degree of noxiousness. Dominant weeds in saffron fields were determined. The results indicated that dominant weeds in saffron fields belong to 19 families and 50 species. *Poaceae*, *Brassicaceae*, *Asteraceae* and *Fabaceae* were dominant families with 11, 9, 8 and 6 species, respectively. The majority of weed species were dicotyledonous, C_3, noxious and annual plants. The highest stability coefficients in growth stages of saffron were calculated in *Alhagi camelorum*, *Avena fatua* and *Achillea millefolium* with 30.81, 24.11 and 12.14, respectively. All weed species except for *Alhagi camelorum* (sustainable species) and *Avena fatua* (temporary species) were recognized as causal species. The highest stability coefficients for vegetative, flowering and dormant stages of saffron were computed with *Achillea millefolium* (12.14), *Avena fatua* (25.11) and *Alhagi camelorum* (52.81), respectively. The highest diversity indices for weed species were recorded at vegetative phase of saffron. The highest diversity indices such as Simpson, Shannon-Wiener, Margalef and Menhinick for weed species were recorded at vegetative phase of saffron with 0.941, 0.898, 1.745 and 3.143, respectively. If weeds could be managed based on sustainable approaches while maintaining crop yield, some unrealized benefits of the presence of weeds and increases in biodiversity could appear.

Keywords: weed biodiversity, stability coefficient, biodiversity index

INTRODUCTION

A weed has been simply defined as “any plant growing in a agroecosystems other than the crop” (Radosevich et al., 2007). A large number of taxonomically diverse plant species behave as a crop weeds with families such as *Poaceae*, *Asteraceae*, *Brassicaceae*, *Apiaceae* and *Fabaceae* being predominant in the weed flora (Hidalgo et al., 1990). However, weeds play a crucial role in biodiversity conservation and agro-ecosystem functioning as they provide several agronomic and ecosystem functions and services. These plants help recycling of nutrients, prevent soil erosion and contribute to removal of noxious chemicals (Altieri, 1999). Moreover, weeds provide a range of resources to support taxa of higher trophic levels, whereas pollen and nectar provide resources for pollinating insects. Furthermore, the plants provide cover and reproduction sites for a number of animals (Marshall et al., 2003; Storkey and Westbury, 2007).

However, weeds have an important role in maintaining farmland functional biodiversity (Bàrberi et al., 2010). A number of studies (Marshall et al., 2003; Storkey et al., 2013) revealed that weed diversity has dramatically declined during the last few decades

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and agricultural intensification has been identified as a major cause.

Saffron has been used as a seasoning spice, as a dye and in ancient drugs since about 2000-1500 BC (Ríos et al., 1996; Fernandez, 2004). Saffron is a fall-flowering geophyte plant with grass-like leaves that appear on or shortly after flowering. It may be a perennial and stem-less plant, with purple flowers. It is triploid and male unfertilized species, therefore, proliferated vegetatively by corm (Negbi, 1999; Fernandez, 2004).

The aims of this paper are to assess weed flora and calculate biodiversity indices in saffron fields of Khorasan province in terms of the possibility of using them in the assessment of field weed communities and their populations.

MATERIALS AND METHODS

A survey trial was done in 50 saffron fields of Khorasan province (including Mashhad, Neyshabur, Torbat-e Jam, Torbat-e Heydarieh, Birjand and Qaen), Iran during 2014 and 2015.

Weed samplings were performed in vegetative growth, dormant and flowering stages of 4-year-old saffron fields. Weed samplings were randomly taken based on systematic method as W pattern (Randall, 2000).

Biodiversity indices were stability coefficient (Krohne and Brewer, 2000), Simpson (Margalef, 1958), Shannon-Wiener (Shannon and Weaver, 1949), Margalef (Margalef, 1958) and Menhinick (Manhinick, 1963). Weeds were grouped based on four characters including vegetation form, photosynthetic pathway, vegetative cycle and degree of noxiousness (Matin Zadeh et al., 2011; Koocheki et al., 2006; Poggio et al., 2004). Dominant weeds in saffron fields were determined.

RESULTS AND DISCUSSION

Fifty weeds were recognized in saffron fields of Khorasan province. Dominant weeds were identified from *Poaceae*, *Brassicaceae*, *Asteraceae* and *Fabaceae* families with 11, 9, 8 and 6 species, respectively. 74% of the weeds were dicotyledonous and the rest were monocotyledonous. Based on photosynthetic pathway, the weed species were classified as C_3, C_4 and CAM with 82, 16 and 2%, respectively (Figure 1).

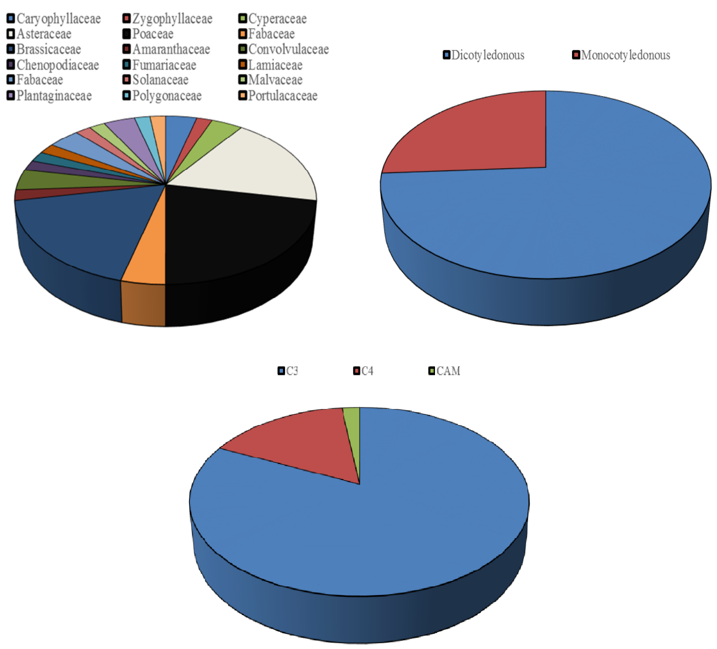

Figure 1. Functional groups of dominant weeds in saffron fields based on species and family.

The highest stability coefficients for dormant, flowering and vegetative stages of saffron fields were calculated for *Alhagi camelorum*, *Avena fatua* and *Achillea millefolium* with 52.81, 25.11 and 12.14, respectively. In all saffron growth stages, *Alhagi camelorum, Avena fatua* and other weed species were recognized as sustainable, temporary and causal species (Figure 2).

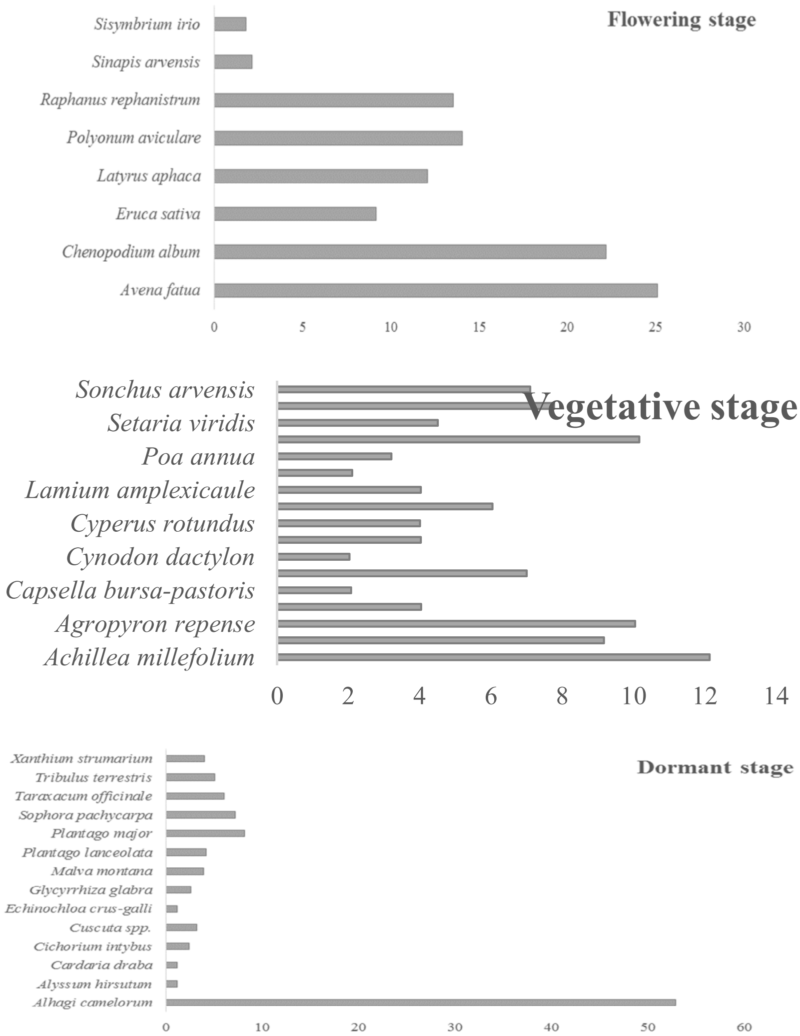

Figure 2. Stability coefficients for weeds in saffron fields at dormant, flowering and vegetative stages.

The highest diversity indices was recorded for vegetative stage of saffron. The highest diversity indices such as Simpson, Shannon-Wiener, Margalef and Menhinick for weed species were recorded at vegetative phase of saffron with 0.941, 0.898, 1.745 and 3.143, respectively (Figure 3).

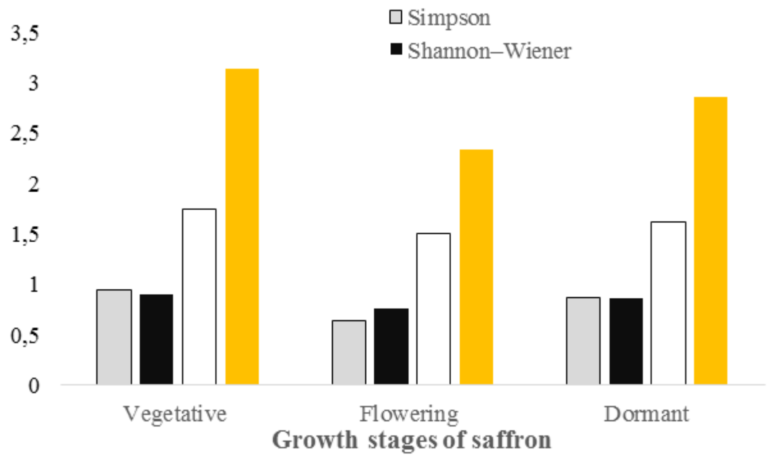

Figure 3. Diversity indices for weeds in saffron fields at dormant, flowering and vegetative stages.

Chemical fertilizers have an indirect impact on plant diversity and weed flora (Kleijn and van der Voort, 1997; Stoate et al., 2001; Kleijn et al., 2009). Herbicides have direct and indirect effects on population and diversity of weeds. Furthermore, the continued reliance on herbicides has selected for resistant populations of steadily increasing number of weed species including the Mediterranean cereal weeds *L. rigidum* and *A. sterilis* (Heap, 2014) creating additional weed control problems.

It has also been shown that functional diversity declines with intensification, indicating a strong environmental filtering imposed by intensive crop management operations (Pakeman, 2011; Guerrero et al., 2014).

CONCLUSION

Chemical weed management decreased the species richness in saffron fields. This suggests that agricultural management played a key role in decreasing the weed species. Reduction in weed density, species diversity and evenness suggests that the use of herbicides may be reduced. However, these findings require further assessments at on-farm level under farmer management practices.

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