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Influence of meteorological factors and agricultural management form on weed species structure in model territory of Agricultural Cooperative Očová

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Abstract

The paper is aimed at evaluation edaphic, ecological , climatic conditions and agricultural management forms on weed diversity structure in relation to optimisation of land use on the model territory of Agricultural Cooperative (AC) Očová (Central Slovakia). The research was carried out using standard methodology for determining the potential weed infestation,, seeds of weed species classification methodology according to Líška (2002), determining the weed species spectrum, richness and diversity via Shannon-Wiener index of diversity and range of ecological dominant weed species in the cultural stands of winter wheat, winter oilseed rape, maize, alfalfa and spring barley for the duration of the experiment. In total, 30 weed species were determined. The most abundant species were: *Persicaria maculata, Sinapis arvensis Amaranthus retroflexus, Chenopodium album, Tripleurospermum maritimum, Rumex acetosa, Fallopia convolvulus.* The research results confirm the influence of soil conditions and amount of atmospheric rainfall only partially. The obtained data indicate that soil quality and rainfall amount play a singnificant role especially in such agrocoenoses where the same crop was cultivated for several years (i.e., alfalfa or permanent lawn).

Key words: weed species richness, agro-environmental scheme, diversity, segetal vegetation, cultural crop

Introduction

Agroecosystems and natural ecosystems have many common features, but differ in several aspects. However, the same biological patterns and relations are characteristic for both types. The functionality of each type of agroecosystems depends on many factors, the major role played by particular climatic factors (rainfall, temperature) closely related to edaphic factors as land as a basic component of agroecosystems contributes significantly to the segetal vegetation diversity within agroecosystems (Tóth 2006).

Agrophytocenoses are sensitive to climate changes, which are accompanied by irregularity of rainfall and an increase of average annual temperatures and average temperatures changed little winter. The influence of climate changes is relatively slow, but is manifested in range of weed vegetation generally and in weed species at particular locations. Booth & Murphy (2003) results refer to plants occurring in warm areas, getting the opportunity to expand into other localities and proceed towards the north, to places inappropriate for them in the past. In recent years we can observe a relatively rapid spread of thermophilic and mediterranean weed species from lowlands to mountainous areas, i.e., *barnyardgrass, pigweed, jimsonweed* and many others by Fjellstad & Dramstatd (2001).The way of agricultural crop management, edaphic and climatic conditions applied in the experimental sites on the model territory of Agricultural Cooperative (AC) allow to assess the influence of edaphic and climatic factors on the weed species abundance and diversity. The aim of this paper is to verify whether the agricultural crop management, edaphic and climatic factors influence the weed species diversity and abundance in chosen cultures of farm crop (Demo et al. 1984).

Materials and methods

The study area was situated on the western foot of the Poľana Mts (eastern border of the Zvolenska kotlina basin, Central Slovakia) and its geographic coordinates are 48º34´04˝ – 48º38´21˝ N and 19º16´52˝ – 19º20´50˝ E (Dublan 1993; Alberty 1999)

The research was carried out in three pairs of sites (6 sites in total). The same crop was planted on both sites within each pair, using different forms of agricultural management (3 crops × 2 management forms = 6 sites). In particular, the conventional form with the application of synthetic fertilizers and pesticides was

altered with the basic agro-environmental scheme or sustainable form (environment-friendly agriculture), without the application of synthetic fertilizers and pesticides.
This method allowed us to study how these two basic forms of agroecosystem management and agricultural crops influence the weed species diversity and abundance in study areas.
The temperature was also one of the main climatic factors, which, together with atmospheric rainfall determined the climatic features of the different locations. Atmospheric rainfall tend to be considered along with the air temperature as the most important meteorological element (Barberi et al. 1998; Borschenius et al. 2004). The occurrence of individual weed species significantly affect inter mentioned meteorological factors, edaphic factors, therefore it is necessary for a comprehensive research on the abundance and identification of weed species on arable land to obtain relevant information on the nature of the climate region and the soil characteristics.
The research was carried out during three growing seasons from 2011 to 2013. Weed seeds samples were collected by PVC cups with volume 100 cm cubic, from depth 0 – 0,1m five times from one site. Weed seeds were sorted manually from the obtained biological material. Subsequently, they were determined to species level ((Hron & Kohout 1986; Černuško 1988).
From the primary data we determined the range of weed species on the sites and weed seeds spectrum, moreover we calculated the weed seeds richness and the number of weed species, identify dominant species, abundance of biological groups of weeds and the Shannon-Wiener index (H´) of species diversity for each year of the experiment.
To assess the impact factors on the value of the total weed abundance, biological groups weed abundance, noxious weed species, weed variety and diversity were used multi-factorial analysis of variance and nonparametric statistical methods by Statistica software and a statistical program Past (Hammer 2001).

Results

The study area was characterized by an average annual temperature of 8.71 ° C. The lowest average monthly temperature was measured in January (-3.2 ° C) and the highest in July (19.5 ° C). Average total atmospherical rainfall for the period was 588 mm. Growing season in 2011 and 2012 was characterized by slightly higher average monthly air temperatures in the long-term average. Especially during the summer months July and August. The rainfall accounted 437.9 mm in 2011, 551.5 mm in 2012, 774.8 mm in 2013; of which the growing season (April-September) rainfall accounted 324.3 mm respectively 308.5 mm and 411.2 mm.

In total, 30 weed species were obtained on the model terrritory. The number of weed species on individual sites varied between number 13 – 23.The most abundant species were: *Persicaria maculata, Sinapis arvensis Amaranthus retroflexus, Chenopodium album, Tripleurospermum maritimum, Rumex acetosa, Fallopia convolvulus.*

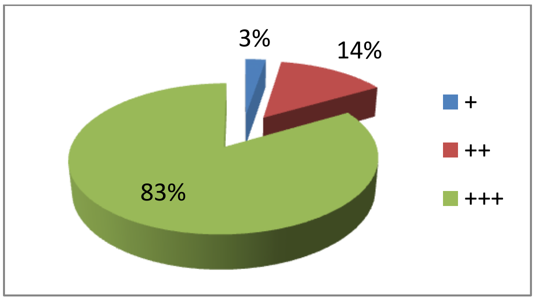

Figure 1. Economic harmfulness of weed species from 2011 to 2013

Population of an individual weed species was quite variable and depends on the amount rainfall fallen during growing season and local average temperatures. For weed species classification according economic harmfulness to the (+ + +) very noxious weeds, (+ +) less noxious weeds, (+) and insignificant species (*) quarantine species were used the Hron and Vodák, (1959) method, which includes general weed species biological characteristics (Fig.1). The phytocenoenoses AC Očová were occupied particular weeds with high potential harmfulness i.e. very noxious, less noxious weed species and quarantine weed species (*), which with extreme competitiveness reduced the quality of chosen cultural crops. Among the quarantine weeds occurring in the area were determined *Datura stramonium, Iva xantifolia.* Based on the biological properties of weeds, we found that the sites were occurred by ephemeral (E), early spring germinated weeds (JS), late spring germinated weeds (JN), winter life cycle weed species (OZ), biennial and perennial weed (DT), perennial shallow rooting (DT / p), perennial deep rooting (DT / h) weed species (Fig. 2). For improving quality of the cultural crops and elimination invasive crop associated weed species was significant factor an agricultural management form.

Cultural crops significantly affected the species composition and abundance of individual weed species (Váľková 2011).

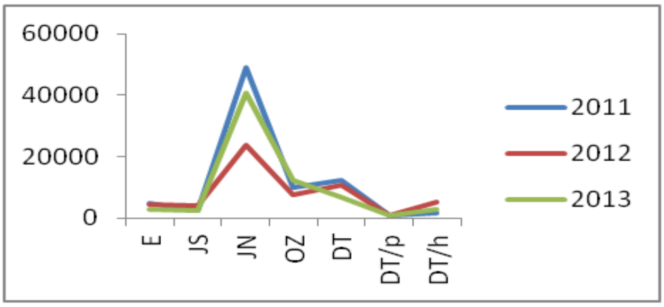

Figure 2. Number of weed seed in biological groups during the period 2011 – 2013

In evaluating the total weed species richness on study sites during the experiment, we recorded a shift in the spectre of weed communities in favor of noxious and very noxious weed species (Liška et al., 2002) in chosen crop plants. Dominant weed species were represented especially by *Persicaria maculata Chenopodium album, Rumex acetosa* and *Echinochloa crus-galli.*

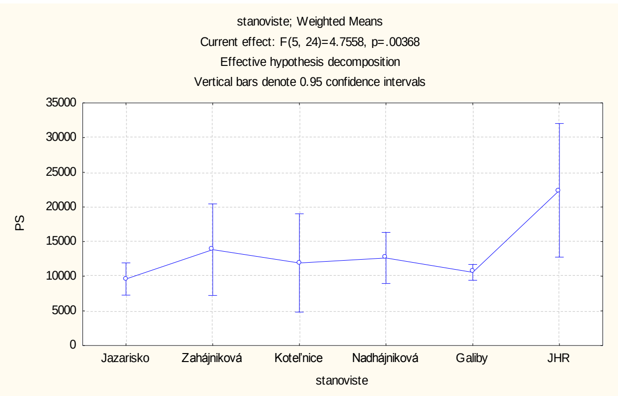

Figure 3. The average abundance of weed seed on study sites in 2011

Meteorological factors affected the abundance of seeds of weed species in agrophytocenoses and largest group represented weed species adaptable to changing climatic and edaphic conditions of individual sites (Gotelli & Colvel 2001).

Evaluating the average abundance of weed seed in 2011 were recorded meteorological factors as a significant factor (ANOVA: df = 5, F = 4.755, p = 0.003), the confidence interval of 0.95. The smallest weed infestation was on low-input site Jazarisko, we measured the highest weed infestation in barley crop on the site JHR

(Fig 3). Temperature and rainfall had a significant dependence on the distribution of weed seeds in the soil.

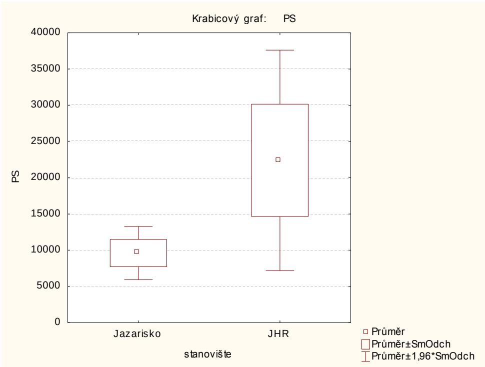

Figure 4. Weed seed richness on the sites Jazarisko-JHR

In 2012, the total proportion of weed infestation on study sites was lower in comparison with 2010. The highest weed infestation in cultural crop was measured on the site JHR (Fig.4). The dominant weed species were represented *Persicaria maculata (Raf.) SF Gray Chenopodium album, Fallopia convolvulus and Echinochloa crus-galli, Amaranthus retroflexus and Atriplex nitens* (Fig 5).

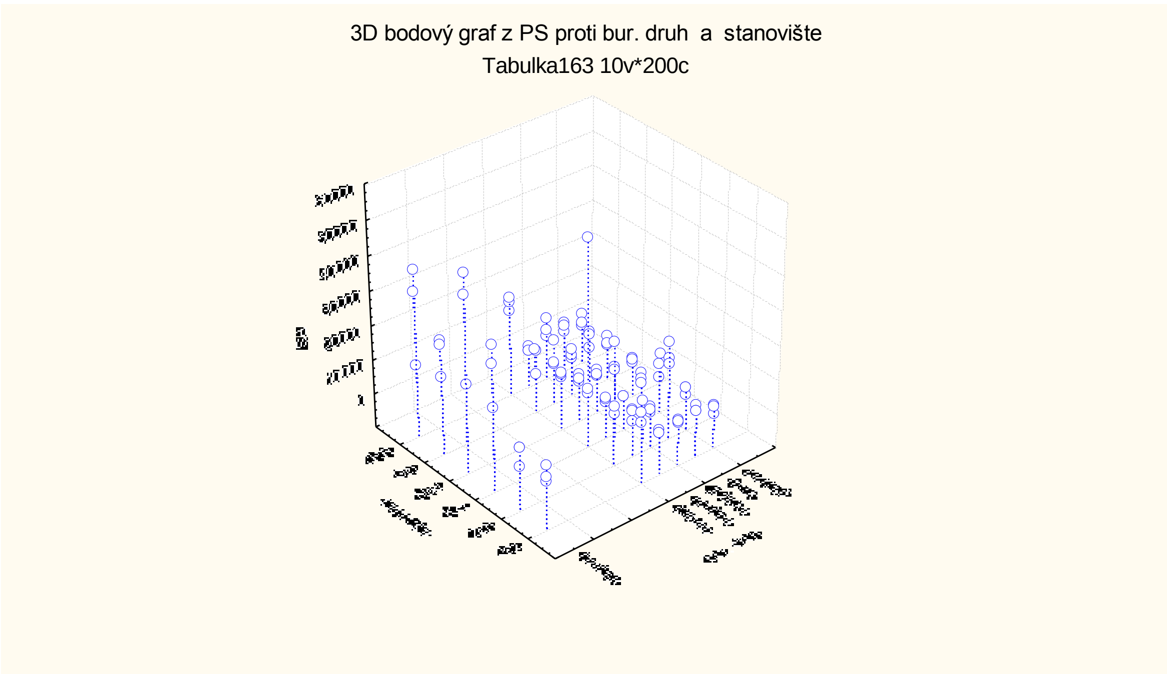

Figure 5. Dominant weed species abundance for the entire duration of the experiment

Furthermore the frequency evaluation of weed species in the crop systems another significant value was diversity in weed communities. The determination of diversity significance of weed species had high explanatory value for understanding the development of agroecosystems. In assessing the dynamics segetal vegetation we calculated the Shannon diversity index H´ for various weeds of the total in agrophytocenoses and Shannon diversity index for sites and monitored according to the chosen statistical factor in each year of the experiment (Shannon 1948). Based on the statistical evaluation and comparison of the total Shannon diversity index for each research site (ANOVA: df = 5, F = 7.599, p = 0.0002) at 0.95 confidence interval the statistically significant factors with the highest influence to weed communities were atmosperical rainfall and habitat (Fig 6).

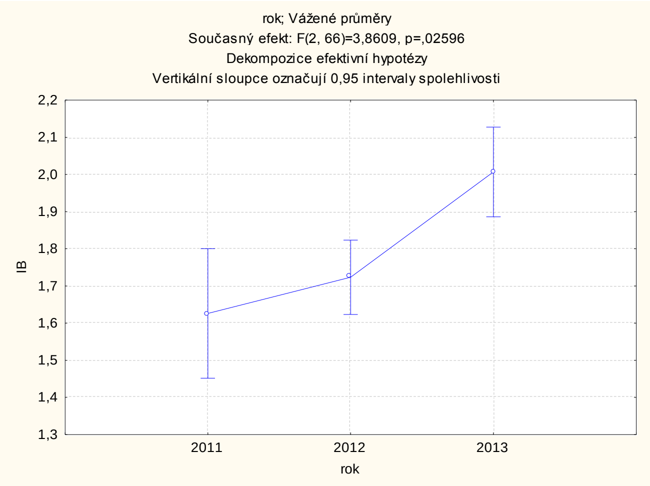

Figure 6. Weed species diversity index for the entire duration of the experiment

Discussion

Determination and weed control in the cultivation system was a complex and systematic activity. Weed agrophytocoenoses were affected by a number of factors. Weeds species found in planted crops were largely influenced by the nature of the habitat, climatic conditions, edaphic factors, methods of land management, Moreover the cosmopolitan weeds have had higher ability of adaptability to wider territories (Černuško & Kollár 1992)., 1997). Changes in weed communities were influenced by agricultural management and environmental factors (Buryšková 1997). The most widespread weed species were *Cirsium arvense (L.) Scop., Persicaria maculata (Rafin.) Fourr., Sinapis arvensis L., Echinochloa crus-galli (L.) PB, Chenopodium* *album L., Rumex acetosa L., Galium aparine L., Capsella bursa-pastoris (L.) Med. , Fallopia convolvulus (L.). Lovey*. What corresponded with the relevant souces (Černuško, 2003; Kohout & Vach 1982; Klaasen & Freitag 2004). Relatively poor species richness composition was reported in 2012 from the entire model territory. This fact probably resulted from unfavourable ecological conditions characterised by specific habitats with large fluctuations of meteorological conditions. Such conditions were unfavourable for many weed species.

In terms of species diversity the sites with sustainable agricultural management was higher than conventional planted sites. Weed species were significantly interconnected to natural environmental and climatic factors, obtained results correspond with Lacko - Bartošová et al 2000; Váľková 2007). Dominant weed species were recorded in both agricultural management forms but the weed seed number difference was not statistically significant value.

The highest number of weed seeds was recorded at JHR site with sustainable agricultural management. JHR was the smallest site with moderate slightly loamy skeletal soil, which was usually seasonally flooded. Dominant weed species represented perennial weeds and the late spring germinated weeds, which were connected to the specific soil type and the type of unit. According to Kováč (2003) the determinated weeds occured in cultural crop plants, which provide the optimum conditions for their life cycle and hence the structure of the composition of the weed crop rotation.

All determined dominant weed species were accounted as very noxious (+++) which required attention to their abundance determination from study area and management for their elimination Kohout 1996; Jehlík et al. 1998).

Conclusion

The obtained results suggest that the land management forms without application agrotechnical measures are important for the increase of weed species diversity conservation in agroecosystems. However, the quality of weed vegetation management is a complex process based on the interaction of many factors and disciplines, to conserve the richness of segetal vegetation within the context of climate changes

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Summary

V práci sme sa zamerali na výskum a hodnotenie segetálnej vegetácie na modelových plochách katastrálneho územia PD Očová v súvislosti so súčasným trendom racionalizácie poľnohospodárskej výroby a managementu burín v kontexte globálnych klimatických zmien.

Naším cieľom bolo zhodnotenie základných pôdnych, meteorologických a ekologických podmienok výskumných plôch a agrotechnických opatrení, ktoré priamo ovplyvňujú dynamiku segetálnej vegetácie v agroekosystémoch na modelovom území. Vyhodnotili sme meteorologické a pôdno-ekologické charakteristiky modelových plôch podľa systému Bonitovaných pôdno-ekologických jednotiek.. Môžeme konštatovať, že výskumné plochy majú rovinnú expozíciu, nachádzajú sa v mierne teplom a vlhkom regióne, pôda je stredne ťažká a ťažká,

hlinitá, utlačená so sklonom k sezónnemu zamokreniu s charakteristickým druhovým zložením sprievodnej vegetácie, ktorá je viazaná na dané pôdno-klimatické podmienky stanovišťa. Definovali sme základné agtechnické opatrenia v konvenčnom a ekologickom systéme hospodárenia a dynamiky segetálnej vegetácie v oboch schémach hospodárenia v súčinnosti s meteorogickými faktormi (teplotou a atmosférickými zrážkami).

Získané semená burinných druhov sme klasifikovali podľa stupnice Hrona, Vodáka(1959). Vyhodnotili sme početnosť a diverzitu burinných druhov pre jednotlivé stanovištia a stanovili sme ekologické dominanty v jednotlivých rokoch trvania experimentu.

Získané empirické údaje sme využili pri štatistickom hodnotení závislostí k stanoveným faktorom- teplota, atmosférické zrážky, stanovišťe a schémy obhospodarovania pôdy a kultúrnej plodiny.

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