STUDYING CORRESPONDENCE OF RAGWEED POLLEN'S AIRBORNE CONCENTRATION AND THE NEW GREENING MEASURES UNDER THE COMMON AGRICULTURE POLICY

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Abstract: *Common ragweed (Ambrosia artemisiifolia) is considered as an invasive alien weed species. Based on the former field surveys, five million hectares, cca. 85% of the Hungarian agricultural area is endangered by ragweed; while around 0.7 million hectares are strongly infected. Cereal stubble is a major habitat of late-growing ragweed populations. Almost 60% of allergic patients (meaning 1.5-2 million people) suffer from ragweed pollen allergy in Hungary. Pollen concentration was measured in the air using Hirst-type pollen traps from year 2000 to 2016 at 19 monitoring stations in Hungary. A map of the crop types were created, using declared parcels of area based payments, validated by remote sensing data. Linear regression was applied to calculate relationship between seasonal pollen index and crop types at each monitoring stations. Our results showed that the land cover area of cereals, corn and sunflower showed positive correlation with ragweed pollen concentrations. This positive correlation had been changed in 2016 that is why we had started to analyse the changes of the system and their potential effects. Unexpectedly, the pollen concentration decreased rapidly in early September of 2016. No precipitation occurred at this time, i.e. reduction of pollen level could not be explained by the wash out of pollen grain from the air by raindrops. Among the possible reasons, the effect of the newly introduced greening obligations related to the area based direct payments (based on the EC regulation 1307/2013) was concerned. The new diversification requirement under the greening contains the possibility of planting catch crops between successive plantings of a main crops, that is why it have a direct effect on the arable stubble management. It is supposed that the late-growing ragweed populations may be suppressed by the catch crops. In order to perform effective ragweed eradication, further studies are needed to optimize agricultural technologies of stubble management.*

Keywords: RAGWEED, POLLEN, GREENING, REGULATION, STUBBLE

1. Introduction

Common ragweed (*Ambrosia artemisiifolia*) is considered as an invasive alien weed species. Based on the former field surveys, five million hectares, cca. 85% of the Hungarian agricultural area is endangered by ragweed; while around 0.7 million hectares are strongly infected. Cereal stubble is a major habitat of late-growing ragweed populations. Almost 60% of allergic patients (meaning 1.5-2 million people) suffer from ragweed pollen allergy in Hungary. Pollen seasons are characterized by high pollen levels (>30 pollen/m^3) from early August to the end of September, but very high levels (>100 pollen/m^3) dominate between the periods of mid August and mid September. There are several methods to control ragweed, including agrotechnical, mechanical, physical, chemical and biological ones [1]. Agricultural politics and financing system has a major influence on the ragweed infestation [2,3]. Ministerial decree (10/2015. (III. 13.)) nominates *Ambrosia artemisiifolia* among dangerous weeds, expressing that it's significant presence precludes the payments and leads to non-compliance of Good Agriculture and Environmental Conditions (GAEC). Moreover the new diversification requirement under the greening contains the possibility of planting catch crops between successive plantings of a main crops based on the newly introduced greening regulation of the Common Agricultural Policy, No 1307/2013 of the European Parliament and of the Council. The Member States had been given the choice to implement different measures according to their own priorities and interest [4], but the diversification of arable crops and to maintain ecological focus area (EFA) on 5% of the arable land is compulsory. Greening has been introduced in Hungary since 2015, offering the possibility of counting as EFA arable parcels with land lying fallow, catch crop and nitrogen fixing crops [5]. The aim of our study is to analyse the potential effect of the new greening measures on the airborne concentration of ragweed pollen.

2. Materials and Methods

The study has been conducted for 4 years (2013-2016) including two drought years (2013 and 2015). Ragweed pollen data were collected at 19 sites using volumetric spore traps of the Hirst design [6] situated at roof level. Air is sucked into the trap at a rate of 10 l/min through a 2 mm x 14 mm orifice. Behind the orifice the air flows over a rotating drum (or microscope slide) that moves past the inlet at 2 mm/h and is covered with an adhesive coated, transparent plastic tape. Following its removal from the trap, the tape is divided into segments corresponding to 24-h periods (48 mm in length). Each segment is mounted between a glass slide and cover slip using a mixture that contains basic fuchsine. The samples are then examined by light microscopy and pollen grains were generally identified at 400 × magnification. Slides were examined along two longitudinal transects following the method described in literature. Due to difficulties such as trap failure several datasets contained missing values. Missing values were replaced by the mean daily average pollen count for that day at the site in question. Daily pollen counts summarized to count yearly the total pollen concentration (so-called seasonal pollen index).

A map of the crop types were created based on anonymous database of declared parcels for area based payments (Agricultural and Rural Development Agency, Hungary/MVH). The map was validated with remote sensing methods [7]. For statistical analysis, the following crops types often having ragweed infestation were selected: cereals, corn, sunflower, oilseed rape, soybean and fallow lands. The total annual land cover areas of these crops were calculated within a certain distance (30 kms) from each pollen monitoring station. Linear regression was applied to calculate relationship between seasonal pollen index and crop types at each monitoring stations.

3. Results

High ragweed pollen concentrations were detected between 2013 and 2016 (Table 1). Ragweed pollen levels were especially high in 2014 and 2016 (6842 and 7221 avg. seasonal pollen index, respectively, while lower in 2013 and 2015 (4046 and 5439). Unexpectedly, the pollen concentration decreased rapidly in early September of 2016 (Fig. 1.).

Table 1. *Seasonal pollen index of ragweed (Ambrosia artemisiifolia) between 2013 and 2016 in 19 monitoring stations in Hungary. n.d.: no data.*

pollen monitoring stations	2013	2014	2015	2016	avg.
Budapest	2 241	3 322	2 334	6 389	3 572
Békéscsaba	7 093	12 220	6 273	8 305	8 473
Debrecen	5 583	10 613	5 530	15 924	9 413
Eger	1 514	3 974	3 111	2 514	2 778
Győr	4 219	5 055	9 731	7 394	6 600
Kaposvár	5 344	6 768	10 148	8 611	7 718
Kecskemét	6 551	12 499	8 107	11 830	9 747
Miskolc	n.d.	5 392	3 348	4 676	4 472
Nyíregyháza	5 185	16 262	3 326	5 069	7 461
Pécs	4 142	5 441	5 111	6 645	5 335
Salgótarján	1 831	2 662	2 487	n.d.	2 327
Szeged	2 285	6 866	4 348	5 901	4 850
Székesfehérvár	5 702	7 691	6 218	6 759	6 593
Szekszárd	4 418	5 784	4 938	6 733	5 468
Szolnok	5 480	9 114	6 076	6 703	6 843
Szombathely	3 148	2 243	n.d.	4 539	3 310
Tatabánya	1 694	4 925	5 845	9 472	5 484
Veszprém	3 496	6 125	7 968	8 546	6 534
Zalaegerszeg	2 899	3 039	2 996	3 971	3 226
avg.	4 046	6 842	5 439	7 221	5 800

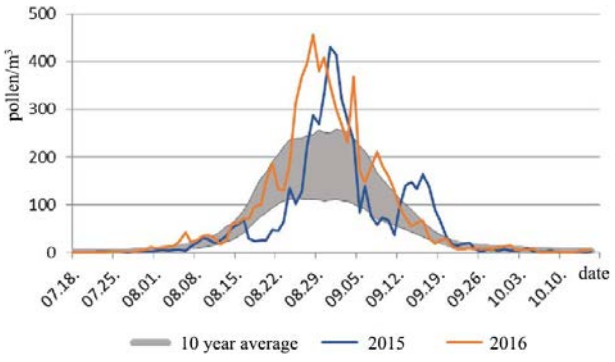

Fig. 1. Pollen concentration of ragweed (*Ambrosia artemisiifolia*) in 2015 and 2016, average of 19 monitoring stations in Hungary.

In this period, the dominant crops were cereals, corn, sunflower, oilseed rape, fallow lands and soybean in descending order of frequency (Fig. 2.)

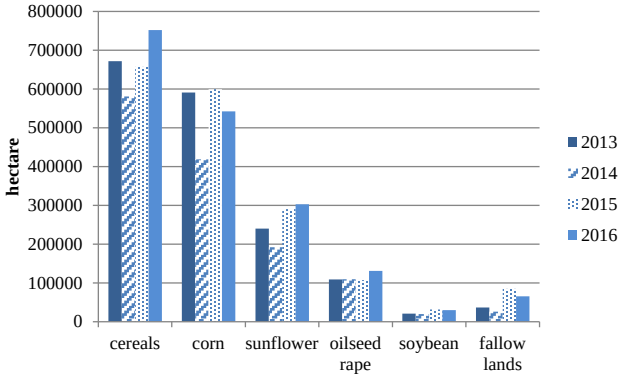

Fig. 2. *Total area of crops in 30 km radius of the Hungarian pollen monitoring stations in 2013-2016.*

The land cover area of cereals, corn and sunflower showed positive correlation with the pollen concentrations in 2013, 2014 and 2015 (Table 2.). However the correlations of cereals turned to negative in 2016 but this is not a significant trend (Fig. 3.). The correlation was negative in oilseed rape and soybean in all years, except for rape seed in 2015. Fallow lands showed positive correlation only in one year (2014).

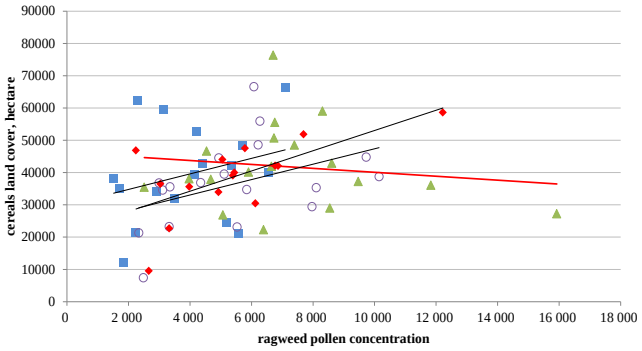

Fig. 3. *The effect of total land cover area of cereals (in hectare) on the seasonal pollen index of ragweed (Ambrosia artemisiifolia) between 2013 and 2016 at the 19 monitoring stations in Hungary. Square: 2013, circle: 2014, triangle: 2015, diamond: 2016. Trend lines: black: 2013-2015, red: 2016.*

Table 2. *Result of regression analysis between the seasonal pollen index of ragweed and total area of crop types in 30 km radius of the Hungarian pollen monitoring stations.*

year	crop type	degree of freedom	R (crop vs. pollen)	R^2 (crop vs. pollen)	significance of trend (p value)
2013	**cereals**	16	0.486	0.237	**0.041**
	corn		0.584	0.341	**0.011**
	sunflower		0.534	0.285	**0.022**
	oilseed rape		-0.064	0.004	0.801
	fallow land		-0.235	0.055	0.348
	soybean		-0.020	0.000	0.936
2014	**cereals**	17	0.168	0.028	0.493
	corn		0.548	0.301	**0.015**
	sunflower		0.559	0.312	**0.013**
	oilseed rape		-0.385	0.148	0.104
	fallow land		0.028	0.001	0.909
	soybean		-0.302	0.091	0.210
2015	**cereals**	16	0.423	0.179	0.081
	corn		0.218	0.048	0.384
	sunflower		0.095	0.009	0.707
	oilseed rape		0.133	0.018	0.598
	fallow land		-0.063	0.004	0.803
	soybean		-0.002	0.000	0.992
2016	**cereals**	16	-0.143	0.020	0.572
	corn		0.398	0.159	0.102
	sunflower		0.133	0.018	0.598
	oilseed rape		-0.591	0.350	**0.010**
	fallow land		-0.168	0.028	0.506
	soybean		-0.330	0.109	0.182

4. Discussion

Our results showed that the land cover area of cereals, corn and sunflower (especially the latter ones) showed positive correlation with ragweed pollen concentrations. It has three main agro-technical aspects:

a. the ragweed infestation of the row crops are high, as to avoid the growth of the ragweed plant in a row crop is either difficult – it requires complex technology and appropriate timing – or rather expensive compared to it's benefit;

b. after harvesting the crop an intensive development of the ragweed starts, as the strongest competitive vegetation had disappeared and after cutting ragweed plants can intensively regenerate and form side shoots;

c. the high seed density of weeds from the previous years (2013 and 2014) remains in the soil and immediately germinates on the stubble after disking as suitable weather conditions exists, in case the lack of proper mechanical stubble management or planting a new catch crop.

This positive correlation (especially in cereals) turned negative in 2016, in the year of applying catch crop as EFA and more rigorous stubble management rules to comply with the GAEC requirements. Greening measures were introduced in spring 2015, so farmers had limited time to plan the crop rotation. On the other hand year 2015 was effected by drought that is why all the correlations were weak. The correlation was strong in 2013 and 2014. Correlation between cereals and pollen levels was stronger in 2013- a drought year, decreasing the vitality of the raw crops- than in 2014. Among the different land-cover types having 'stubble' infested with ragweed cereal stubble had the highest number and area, according the database of the Hungarian Ragweed Information System. In 2016 the catch crop seeded on cereal stubble area had been increased with 28%.

Apparently, ragweed populations growing on cereal stubble are one of main sources of airborne pollen in Hungary. Although proper – weed free – stubble management is required by the GAEC rules since 2008, the EFA requirement under greening seems to have stronger effect on stubble management. Greening forces planting catch crops between successive plantings of a main crops, that is why it have a direct effect on the arable stubble management. It is supposed that the late-growing ragweed populations may be suppressed by the catch crops. Greening also offers to use fallow land as an EFA, and the rule of GAEC - including the eradication of all dangerous weeds – are more strictly kept by the farmers. Proper and the required fallow land management opens the possibility of germinating the ragweed seeds on a way that no arable crop is damaged, and decreasing significantly the seed content of the soil by eliminating the plant before flowering.

Albeit the average seasonal pollen index was high, an unexpected, rapid decrease in pollen concentration was observed in early September of 2016. Similar drop in pollen levels is usually caused by precipitation (pollen grains are washed out from the air). However, no precipitation occurred in this time. It seems that greening may have a positive effect on ragweed pollen concentration, i.e. reduction of airborne allergen burden of the human population. However further studies are needed with an extended period of monitoring the new measure to confirm this suspicion. Greening of cereal crops (stubble) in Somogy county (West Hungary) in 2016 are illustrated in Fig. 4. and Table 3.

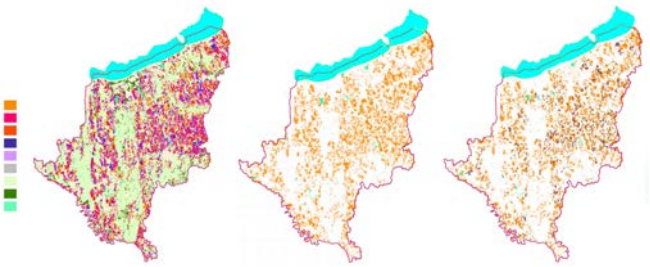

Fig. 4. *Land cover map of Somogy county (West Hungary) in year 2016. yellow: cereals, red: corn, orange: sunflower, dark blue: oilseed rape, purple: soybean, grey: fallow lands, light green: forest, dark green: pastures, blue: water. Left: all crops, middle: cereals, right: cereals (stubble) and greening (brown).*

Table 3. *Quantitative data of greening in Somogy county, in year 2016.*

categories	area (ha)
eligible area	309 255
total area of cereals	88 649
total catch crop area (declared for greening)	20 623
total area of catch crops on cereal stubbles (declared for greening)	13 367

The potential effect of this change in the arable land management technology on the pollen levels could be quantified by remote sensing techniques measuring the area and timing aspects of stubble-fields existence with and without the cultivation of catch crops and with and without the presence of herbaceous weeds on the stubble. In order to perform effective ragweed eradication, further studies are needed to optimize the combination of different agricultural technologies of stubble management. Besides greening the application of other agricultural methods could also be considered, e.g. crop rotation, mechanical cutting/disking of ragweed before flowering. The effectiveness of ragweed control measures could be monitored by pollen observation [8] as well as by satellite observation and its validation with on-the-spot observations of ragweed plants.

4. Conclusion

Ragweed area, the air pollen concentration and it's correlations with other elements had been monitored in Hungary for many years, and we have noticed an unexpected change in 2016. Looking for the potential reasons, we had found that the Hungarian GAEC and greening rules forces several crop management technological actions targeting the decrease of ragweed infection. Our study found that apparently greening could become an effective tool in ragweed control, as most probably the required activities caused the decrease of the air pollen content at mid-summer period that is why it needs more study and more years to test if it has significant impact on airborne ragweed pollen levels.

5. References

[1] Kazinczi, G. – Novák, R.: Integrated Methods for Suppression of Ragweed. National Food Chain Safety Office, Directorate of Plant Protection, Soil Conservation and Agri -environment, Budapest (2014)

[2] Kiss, L. – Béres, I.: Anthropogenic factors behind the recent population expansion of common ragweed (*Ambrosia artemisiifolia* L.) in Eastern Europe: is there a correlation with political transitions? – J. Biogeogr. (2006) 33: 2156–2157.

[3] Pinke, Gy. - Karácsony, P. – Czúcz, B. - Botta-Dukát, Z.: Environmental and land-use variables determining the abundance of *Ambrosia artemisiifolia* in arable fields in Hungary. Preslia (2011) 83(2), 219-235.

[4] Burny, P.: Greening of the Common Agricultural Policy: implementation in Wallonia (South of Belgium). Calitatea (2014) 15(S1), 103.

[5] Csonka, B. - Tapsonyi, T. - Szabó, E. – Szerletics, Á.: Managing EFA declarations and the development of LPIS in year 2015. GAEC WS – Prague (2015)

[6] Hirst, J.M.: An automatic volumetric spore trap. Ann. Appl. Biol. (1952) 39(2), 257-265.

[7] Surek, Gy. – Nádor, G. – Hubik, I. – Gera, D. – Kulcsár, A. – Török, C.: Advances in ragweed identification by remote sensing, Second International Ragweed conference, 28-29 March, 2012, Lyon, France (2012)

[8] Sikoparija, B. – Skjøth, C. – Celenk, S. – Testoni, C. – Abramidze, T. - Alm Kübler, K. – Belmonte, J. – Berger, U. – Bonini, M. – Charalampopoulos, A. – Damialis, A. – Clot, B. – Dahl, Å. - de Weger, L.A. – Gehrig, R. – Hendrickx, M. – Hoebeke, L. – Ianovici, N. - Kofol Seliger, A. – Magyar, D. – Mányoki, G. – Milkovska, S. – Myszkowska, D. – Páldy, A. – Pashley, C.H. – Rasmussen, K. – Ritenberga, O. – Rodinkova, V. – Rybníček, O. – Shalaboda, V. – Šaulienė, I. – Ščevková, J. – Stjepanović, B. – Thibaudon, M. – Verstraeten, C. – Vokou, D. – Yankova, R. – Smith, M.: Spatial and Temporal Variations in Airborne *Ambrosia* Pollen in Europe. Aerobiologia, 1-9. (2016)