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AN ANALYSIS OF GRASS (POACEAE) POLLEN SEASONS IN LUBLIN IN 2001-2008

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Abstract

Grass pollen allergens are a frequent cause of pollen allergy in Poland and other European countries. The research on aeroplankton conducted in Lublin since 2001 allows characterization of the course of grass pollen seasons and estimation of the effect of maximum and minimum temperatures, relative air humidity, precipitation and maximum wind velocity on the taxon's pollen concentration. The gravimetric method was used in the study. During the eight-year research period, the pollen season usually started in the first or second decade of May and, as a rule, it lasted till the end of August, and quite exceptionally, in 2002 and 2008 till mid-August. The mean length of the pollen season was 107 days. The highest grass pollen risk was observed in the 26th and 27th week. The highest annual counts reaching over 3600 pollen grains× cm^{-2} were noted in 2008, while in the other study years they ranged from 741 to 1909. The date of the pollen season onset and its course were highly dependent on weather conditions, which was confirmed by the statistical analysis. The greatest significant influence on the pollen season was exerted by maximum temperature, relative air humidity and the maximum wind.

Key words: aerobiology, Poaceae, pollen season, annual counts, maximum count, meteorological conditions

INTRODUCTION

Poaceae are cosmopolitan plants which cover almost 20% of the land area. They comprise more than 9 thousand species (Tutin (Ed.), 1980; Clayton, 1993). They constitute a valuable source of food, protect the natural environment and facilitate recreational activities (Mizianty, 1995; Frey, 2000). In Poland, grass communities cover 4.1 mln ha, which equals 13.4 % of the country area. Their biggest agglomerations are found in the north-eastern and southern parts of the country (Niczyporuk, 2000; Rogalski, 2004).

Grasses are predominantly anemophylous plants (Weryszko-Chmielewska and Piotrowska, 2006). Their flowers produce great amounts of pollen (*Poa annua* approximately 1 000 pollen grains/flower, 115 000/inflorescence, *Dactylis glomerata* 10 000/7 970 000, *Festuca arundinacea* 26 800/11 700 000), which is released within several minutes or a few hours, depending on the species (Piotrowska, 1999; Prieto-Baena et al. 2003; Aboulaich et al. 2009). The species variety in the grass family results in pollen presence in the air for many months of the year (Rutkowski, 1998; Piotrowska and Weryszko-Chmielewska, 2004; Puc and Puc, 2004). Grass pollen allergens are one of the main reasons for pollen allergy incidence in Poland and other European countries (Spieksma, 1989). More than 80% of patients with plant pollen allergy suffer from that caused by grass pollen (Obtułowicz et al. 1990). The strongest allergens are those of *Phleum*, *Dactylis*, *Lolium*, *Festuca*, *Poa*, *Anthoxanthum*, *Holcus*, *Agrostis* and *Alopecurus.* Cross reactions are often observed between the allergens of Poaceae pollen and those of peas, beans, peanuts, kiwi, melons or strawberries (Subiza, 2003; Abreu et al. 2008). Atmospheric conditions may have a great impact on the timing and abundance of grass pollen grains in the air (Emberlin et al. 1994, 2000; Norris-Hill, 1999; Sánchez-Mesa et al. 2003, 2005; Clary et al. 2004; Peternel et al. 2006; Smith and Emberlin, 2006; Stach et al. 2008; Garcia-Mozo, 2009).

The aim of the study was characterization of the grass pollen seasons and estimation of the effect of maximum and minimum temperature, relative air humidity, precipitation and maximum wind velocity on the concentration of the taxon's pollen.

MATERIALS AND METHODS

The measurement of grass (Poaceae) pollen fall was done by the gravimetric method with the use of

a Durham sampler (D u r h a m , 1964). The sampler was placed in the western part of the city, in the Maria Curie-Skłodowska University Botanical Garden in Lublin (51° 16`N, 22° 30`E), 5 metres above ground level (220 m AMSL). The pollen fall was expressed as the number of pollen grains per 1 cm^{-2} of slide surface, collected per day, in the years 2003, 2008 and per week (2001, 2002, 2004-2007).

On the basis of the results obtained, the date of the onset and end of the pollen season was determined as well as the length of season, the annual pollen count and the periods of their maximum concentrations. In order to analyse the influence of meteorological factors on the pollen season, daily values of five weather elements were taken into account: maximum and minimum temperature, relative air humidity, precipitation and maximum wind velocity noted from May to August 2001-2008, as well as minimum temperature of January in 2001-2008. The data were obtained from the weather station of the UMCS Institute of Meteorology and Climatology situated 3 km from the measurement site.

Pearson's r correlation coefficients were calculated with the use of Statistica 7.1 StartSoft Inc. software to examine the correlations between the particular season features and weather conditions.

RESULTS

During eight years, the grass pollen season usually began in the first or second decade of May (Tab. 1). Maximum temperatures above 17°C from the 10 days that preceded flowering initiated the onset of pollen release, which is confirmed by the significant correlation coefficient r = 0.2560. Ground frost in May delayed flowering, which is indicated by the high correlation coefficient r = - 0.9151. In the years of study, the grass pollen season basically lasted till the end of August and exceptionally ended in the middle of the month in 2002 and 2008. The mean length of the pollen season was 107 days (Tab. 1).

Table 1

Results of the aerobiological study of grass pollen fall in Lublin in 2001-2008.

Years	Length of pollen season			Annual count/cm^{-2}	Maximum pollen count		% of annual count
	onset	end	duration (days)		grains× cm^{-2}/day	week number	
2001	16.05	29.08	105	1767	48.7 and 48	21. 27	2.7
2002	1.05	14.08	106	1483	30.8 and 30	25. 26	2.1
2003	30.04	27.08	120	1538	39	26	2.5
2004	12.05	25.08	105	741	18.4	28	2.5
2005	23.05	31.08	100	992	33.7 and 32.8	26. 27	3.3
2006	11.05	30.08	111	1196	39.3	27	3.3
2007	9.05	29.08	112	1909	51.4	25	2.7
2008	13.05	17.08	96	3615	176.8	27	4.9

The highest annual counts, more than 3600 pollen grains × cm^{-2}, were observed in 2008; in the other years of study, the counts ranged from 741 to 1909. A significant negative value of the correlation coefficient r = – 0.4729 was obtained between the annual grass pollen count and the minimum temperature of January. The linear trend function was used for estimation of the tendency in the changes in the annual grass pollen counts (Fig. 1). The trend line indicates a remarkable increase in the annual counts.

The highest allergenic risk posed by grass pollen was noted in the 26th and 27th week (Tab. 1). The daily concentration reached 30 pollen grains × cm^{-2}/day. The record concentration of Poaceae pollen reaching 176.8 grains × cm^{-2}/day, which equalled almost 5% of the annual count, was reported in 2008. In the other seasons, the pollen concentration was 2-3 times lower. In 2004 grass pollen allergens posed the least risk. In the years of study, a very high grass pollen concentration persisted during 2 to 5 weeks each year (Tab. 2).

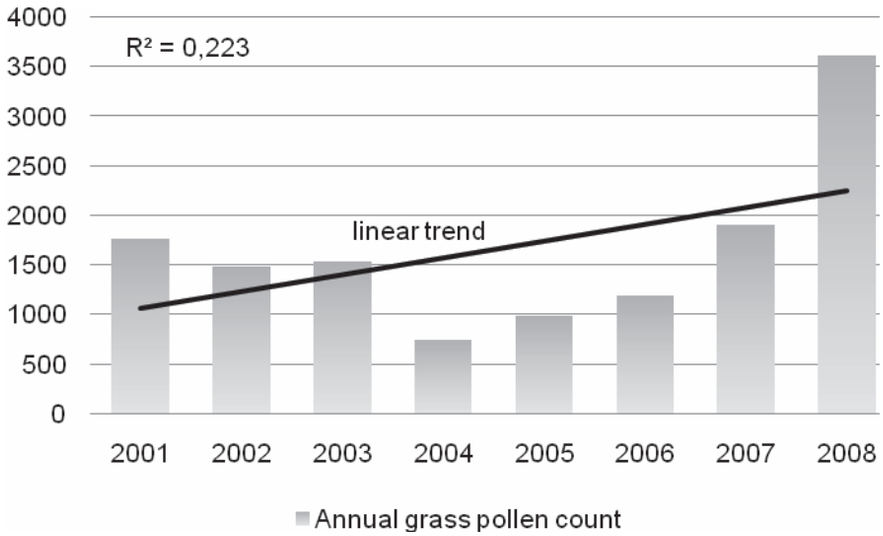

Fig. 1. Annual grass pollen counts in Lublin in 2001-2008.

Table 2

Number of weeks of each allergenicity rank (according to the CAN threshold system Belmonte et al. 2000) for each investigated year in Lublin.

	Number of weeks of each allergenicity rank				
Years	Null 0.0 **0**	Low 0.1-4.9 **1**	Mid 5-19.9 **2**	High 20-29.9 **3**	Very high >30 **4**
2001	31	12	2	4	3
2002	29	13	5	3	2
2003	30	13	6	0	3
2004	36	8	9	0	0
2005	35	9	6	0	2
2006	35	10	5	1	2
2007	30	14	3	1	4
2008	30	12	3	2	5

The statistical analysis demonstrated a significant positive correlation between the grass pollen fall and maximum air temperature in five out of the eight study years (Tab. 3). The decrease in temperature in the seasons 2001 and 2002 was accompanied by a fall in the concentration of the taxon's pollen, which is indicated by significant correlation coefficients. In the years 2002, 2005 and 2006, a marked, statistically significant increase in pollen concentration was observed alongside a decrease in relative air humidity. Insufficient precipitation in the seasons of 2005 and 2006 increased the concentration of pollen grains in the air, which was confirmed by the statistic analysis. In the case of wind velocity, a statistically significant correlation was reported in 2005, 2006 and 2008. This confirms the observation that the stronger the wind, the higher concentration of grass pollen grains in the air.

Table 3
Pearson's r correlation coefficients for the grass pollen fall and weather parameters (2001-2008).

Years	Max. temp. (C°)	Min. temp. (C°)	Relative humidity (%)	Precipitation (mm)	Max.wind (m/s)
2001	0.4339*	-0.4040*	-0.0958	-0.1572	-0.1916
2002	0.5286*	-0.2940*	-0.2990*	0.2687	0.1754
2003	0.0898	0.0426	-0.0434	-0.1393	0.0740
2004	0.1148	0.0136	-0.1453	-0.1095	-0.1495
2005	0.1894	0.1971	-0.4598*	-0.2957*	0.2668*
2006	0.3034*	0.2210	-0.3893*	-0.4452*	0.3561*
2007	0.2134*	0.1947	-0.0960	-0.0797	-0.0712
2008	0.3567*	0.1894	-0.1822	0.0794	0.2640*

* – a statistically significant correlation coefficient ($p<0.05$).

DISCUSSION

The grass pollen season in Lublin starts in the first or second half of May; similar results were obtained by authors of aerobiological studies in various regions of Poland (Kasprzyk, 2002; Puc, 2002; Piotrowska and Weryszko-Chmielewska, 2004; Puc and Puc, 2004; Piotrowska, 2006; Weryszko-Chmielewska (Ed.), 2006; Chłopek, 2007), England (Sánchez-Mesa et al. 2003; Smith and Emberlin, 2006), Denmark, Germany and Austria (Emberlin et al. 2000). In the colder part of Europe – in Norway and Finland – grasses begin releasing pollen at the end of June and beginning of July (Emberlin et al. 2000), while in the south of Europe, e.g. in Spain, Portugal and Croatia, pollen release starts at the turn of March and April (Fernández-González, 1999; Peternel et al. 2005, 2006; Abreu et al. 2008; García-Mozo et al. 2009).

In their phenological observations of grass pollen release in various European regions, Emberlin et al. (1994, 2000), Sánchez-Mesa et al. (2005), Smith and Emberlin (2006) as well as Stach et al. (2008) reported a significant effect of temperature on the onset of Poaceae flowering. Similar observations were reported in Lublin in the years 2001-2008.

In Poland and other European countries, grasses end flowering on the last days of August (Fernández-González, 1999; Kasprzyk, 2002; Piotrowska and Weryszko-Chmielewska, 2004; Puc and Puc, 2004; Peternel et al. 2005, 2006; Piotrowska, 2006; Weryszko-Chmielewska (Ed.), 2006; Abreu et al. 2008).

Long-term aeropalynological research conducted worldwide is an attempt to establish trends in macroregional changes in grass pollen concentration. While analyzing their results obtained from numerous seasons, Fernández-González (1999) and Sánchez-Mesa et al. (2003) observed slight trends towards an increased Poaceae concentration. An increase in the annual counts was also reported in Lublin during the eight study years.

The highest risk posed by grass pollen allergens was reported in Lublin at the end of June and beginning of July, i.e., in the 26th and 27th weeks. Similar results were presented by Sánchez-Mesa et al. (2003) in their study in England. In Spain and Croatia, high grass pollen content at the end of May, i.e. in the 22nd week, was noted by Fernández-González (1999), Sánchez-Mesa et al. (2003), Latorre and Belmonte (2004), Peternel et al. (2005, 2006), Abreu et al. (2008), and García-Mozo et al. (2009).

The results obtained by Peternel et al. (2006) from Zagreb, Latorre and Belmonte (2004) from Catalonia as well as by Smith and Emberlin (2006) from London demonstrate that a very high concentration of grass pollen allergens (over 30 pollen grains × m^{-3}/day) persists from 4 to 5 weeks. In Lublin, such concentration persisted over 2.5 weeks.

The grass pollen concentration in the air in Lublin was positively and significantly correlated with maximum air temperature and maximum wind velocity. A similar correlation was observed by Norris-

Hill (1999), Puc (2002), Sánchez-Mesa et al. (2003, 2005), Puc and Puc (2004), Peternel et al. (2006), Smith and Emberlin (2006), and Stach et al. (2008). An increase in the grass pollen concentration accompanying a fall in relative air humidity and precipitation was noted by, among others, Sánchez-Mesa et al. (2003, 2005), Puc and Puc (2004), and Peternel et al. (2006).

CONCLUSIONS

1. The differences in grass pollen release in the area of Lublin in the years 2001-2008 related to the dates of appearance of pollen grains in the air, length of pollen seasons, annual pollen count and maximum pollen concentrations.
2. The onset of the grass pollen season was dependent on maximum and minimum temperatures.
3. The trend line indicates a marked increase in the annual counts of grass pollen grains in the course of the seasons.
4. The maximum grass pollen concentration, i.e., over 30 grains × cm^{-2}/day, was observed in the 26th and 27th weeks.
5. The grass pollen concentration in the air displays a statistically significant correlation with maximum and minimum air temperatures, relative air humidity, precipitation and maximum wind velocity.

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Analiza sezonów pyłkowych traw (Poaceae) w Lublinie w latach 2001-2008

Streszczenie

Alergeny pyłku traw są częstą przyczyną alergii pyłkowej w Polsce oraz innych krajach Europy. Prowadzone w Lublinie od 2001 roku badania aeroplanktonu posłużyły do scharakteryzowania przebiegu sezonów pyłkowych traw oraz oceny wpływów temperatury maksymalnej i minimalnej, wilgotności względnej powietrza, opadów i maksymalnej prędkości wiatru na koncentrację pyłku tego taksonu. Badania przeprowadzono metodą grawimetryczną. W ciągu ośmiu lat badań, sezon pyłkowy traw rozpoczynał się zwykle w pierwszej lub drugiej dekadzie maja i trwał z reguły do końca sierpnia, wyjątkowo w 2002 i 2008 roku do połowy sierpnia. Średnia długość sezonu pyłkowego wynosiła 107 dni. Największe zagrożenie alergenami pyłku tego taksonu zarejestrowano w 26 i 27 tygodniu. Najwyższe sumy roczne zanotowano w 2008 roku, ponad 3600 ziaren pyłku $\times$ cm^{-2}, natomiast w pozostałych latach badań sumy zawierały się pomiędzy 741 a 1909. Termin początku sezonu pyłkowego i jego przebieg w znacznej mierze zależały od warunków pogodowych, co potwierdziły wyniki analizy statystycznej. Największy istotny wpływ na sezon pyłkowy wywierała temperatura maksymalna, wilgotność względna powietrza oraz maksymalna prędkość wiatru.