

POLLEN SEASON 2025 IN THE BRATISLAVA AREA

PEĽOVÁ SEZÓNA 2025 NA ÚZEMÍ BRATISLAVY

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Abstract

In 2025, a total of 91,465 pollen grains were recorded in the air of Bratislava, representing a 107% increase compared to the long-term mean from 2002 to 2024. Cupressaceae/Taxaceae was the most abundant pollen type, contributing 22% of the annual pollen load, followed by Urticaceae, *Populus*, Pinaceae, *Fraxinus*, *Ambrosia*, *Alnus*, *Betula*, *Quercus*, and Poaceae, which together accounted for 87% of the total pollen count. Except for *Betula*, all prominently represented taxa exhibited enhanced pollen seasons, reflected by higher Seasonal Pollen Integral (SPIn) and peak values relative to the long-term mean. The magnitude of SPIn increases varied among taxa, ranging from +44% for Urticaceae to +334% for Cupressaceae/Taxaceae. Notable shifts in the timing of pollen seasons were observed for the dominant taxa: except for Pinaceae, pollen seasons generally started earlier, by up to 19 days for Urticaceae and 15 days for *Quercus*. With the exception of Cupressaceae/Taxaceae, Pinaceae and *Alnus*, the pollen seasons of all major taxa were prolonged by up to 16 days in the case of Poaceae. In contrast, the pollen season of Cupressaceae/Taxaceae, despite its increased SPIn, was shortened by 6 days.

Keywords: seasonal pollen dynamics, pollen phenology, meteorological factors

Introduction

Monitoring of airborne pollen is essential for understanding seasonal trends and their impact on human health. In urban areas like Bratislava, local climate and vegetation strongly influence the timing, intensity, and duration of pollen seasons, which in turn affect allergy prevalence and exposure risk (Schramm et al. 2021; Ščevková et al. 2024, 2025; Štefániková et al. 2026). Long-term pollen data also provide valuable insights into phenological responses of plant taxa to environmental changes.

This study analyses the 2025 pollen season in the Bratislava area, focusing on variations in pollen concentration, season onset, and duration relative to long-term averages, thereby providing updated evidence on the dynamics of airborne pollen in a Central European urban environment.

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Material and methods

Airborne pollen samples were collected between 1 February and 23 November 2025 using a Burkard Hirst-type volumetric pollen trap installed on the roof of the Science Park building at Comenius University (48° 08' 58" N, 17° 04' 24" E; 18 m above ground level).

Samples were processed using commonly accepted aerobiological methods, in accordance with the requirements of the European Aerobiology Society (Galán et al. 2014) and the European Standard EN 16868 (2019). Pollen grains were quantified on microscope slides at a magnification of $\times 400$ using the 12 vertical transects approach. After applying a correction factor, the resulting data reflect the mean daily pollen concentration per taxon (pollen/m³).

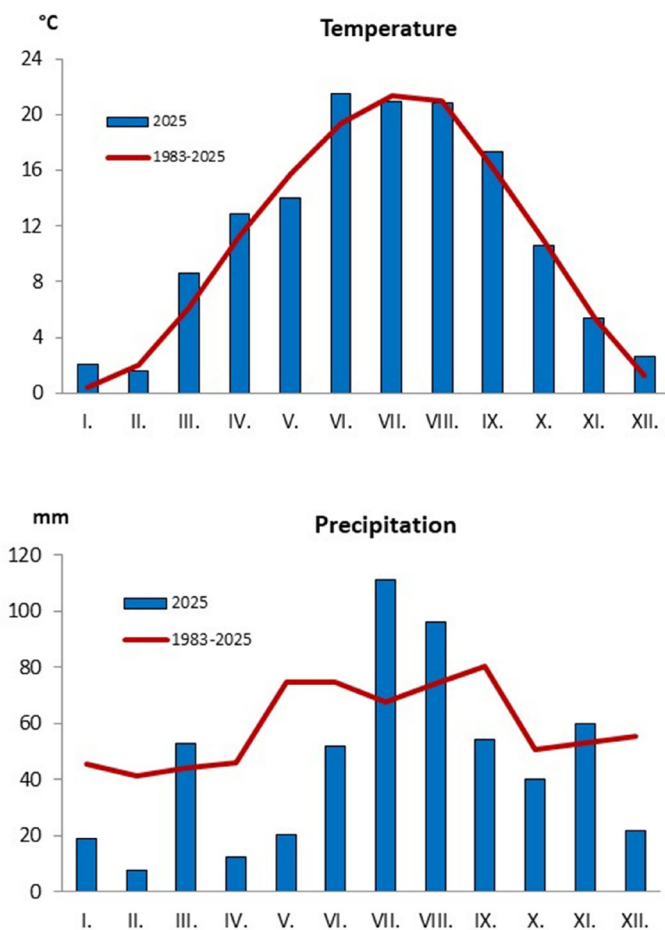


Fig. 1. Mean monthly air temperature and total monthly precipitation values in Bratislava

Obr. 1. Priemerné mesačné hodnoty teploty vzduchu a mesačné úhrny zrážok v Bratislave

Tab. 1. The total monthly airborne pollen concentrations in Bratislava in 2025

Tab. 1. Sumárne mesačné koncentrácie peľu v ovzduší Bratislavy v roku 2025

Taxon/Month	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	%
<i>Acer</i>		107	23								0.14
<i>Aesculus</i>		29	413	70							0.56
<i>Ailanthus</i>				12	221	6					0.26
<i>Alnus</i>	1,027	3,905	94	3	6						5.5
<i>Ambrosia</i>						16	2,857	2,536	69	15	6.01
Apiaceae			14	3	3	10	10	1			0.04
<i>Artemisia</i>						5	429	84	4		0.57
Asteraceae			1		10	7	5	13	5		0.04
<i>Betula</i>		1,187	3,771	58	4						5.49
<i>Carpinus</i>		1,006	2,089	5							3.39
<i>Castanea</i>					183	1					0.2
Chenopodiaceae				1	40	87	366	158	16	1	0.73
<i>Corylus</i>	439	510	78	5							1.13
Cup/Tax*	1,282	17,574	712	27	92	194	109	26	2	2	21.89
<i>Fagus</i>			181	17							0.22
<i>Fraxinus</i>	12	5,653	1,682	17							8.05
<i>Humulus</i>							887	39	1		1.01
<i>Juglans</i>			266	95	1						0.4
<i>Larix</i>		1	7								0.01
Pinaceae	3	6	659	6,484	333	43	17	14	8	6	8.28
<i>Plantago</i>			3	59	409	286	438	182	7		1.51
<i>Platanus</i>			78								0.09
Poaceae			64	1,021	2,144	402	157	143	11	1	4.31
<i>Populus</i>	12	7,148	2,307								10.35
<i>Quercus</i>		369	3,953	403	4						5.17
<i>Rumex</i>			7	81	199	24	19	9	4		0.38
<i>Salix</i>		316	832	51							1.31
<i>Sambucus</i>				155	91						0.27
<i>Tilia</i>					200	20					0.24
<i>Ulmus</i>	7	408	18								0.47
Urticaceae			707	340	3,149	1,789	4,468	471	24	5	11.98
Total	2,782	38,219	17,959	8,907	7,089	2,890	9,762	3,676	151	30	100

*Cup/Tax – Cupressaceae/Taxaceae

The Main Pollen Season (MPS) was determined using the 90% method described by Nilsson and Persson (1981).

In 2025, the study area experienced an average daily air temperature of 11.5°C and total precipitation of 547.4 mm, representing an increase of 0.6°C in temperature and a decrease of 23% in precipitation compared to the long-term mean for 1983–2025 (SHMÚ) (Fig. 1).

Results and discussion

As in previous years (Ščevková and Dušička 2024, 2025), 31 pollen taxa (21 arboreal and 10 herbaceous) were recorded in the air of Bratislava in 2025 (Tab. 1). The Annual Pollen Integral (APIn), representing the yearly total of average daily pollen concentrations, reached 91,465 pollen*day/m³ (107% above the 2002–2024 average reported by Comenius University, Department of Botany). The most abundant taxa were: Cupressaceae/Taxaceae (21.9% of the total), Urticaceae (12%), *Populus* (10.4%), Pinaceae (8.3%), *Fraxinus* (8.1%), *Ambrosia* (6%), *Alnus* (5.5%), *Betula* (5.5%), *Quercus* (5.2%), and Poaceae (4.3%) (Tab. 1).

Except for July, the total monthly pollen concentrations from March to August exceeded 7,000 pollen/m³. The highest monthly airborne pollen concentration was recorded in March (38,219 pollen/m³), dominated by Cupressaceae/Taxaceae, *Populus*, *Fraxinus*, and *Alnus*. High concentrations were also observed in April (17,959 pollen/m³), with *Quercus* and *Betula* prevailing (Tab. 1).

Tab. 2. The MPS characteristics of the most abundant pollen types in the air of Bratislava in 2025

Tab. 2. Charakteristiky MPS dominantne zastúpených typov peľových zŕn v ovzduší Bratislavy v roku 2025

Taxon	Main pollen season					
	Start	End	Duration (days)	Peak (pollen/m ³)	Peak date	SPIn (pollen*day/m ³)
<i>Alnus</i>	20. II	17. III	26	867	6. III	4,594
<i>Ambrosia</i>	13. VIII	21. IX	40	537	28. VIII	5,098
<i>Betula</i>	26. III	20. IV	26	1,107	5. IV	4,602
<i>Carpinus</i>	22. III	13. IV	23	472	5. IV	2,929
Cup/Tax	25. II	3. IV	38	4,238	5. III	18,704
<i>Fraxinus</i>	10. III	13. IV	35	707	23. III	6,669
Pinaceae	30. IV	1. VI	33	743	15. V	6,871
Poaceae	9. V	22. VIII	106	161	19. VI	3,554
<i>Populus</i>	9. III	11. IV	34	952	10. III	8,837
<i>Quercus</i>	27. III	4. V	39	450	21. IV	4,350
Urticaceae	28. IV	30. VIII	125	381	11. VIII	9,953

SPIn (Seasonal pollen integral) – the sum of the mean daily pollen concentrations over the MPS

Tab. 2 summarises the MPS characteristics of abundantly represented taxa. In 2025, the onset of the pollen season occurred earlier for all analysed taxa except Pinaceae when compared with the 2002–2024 long-term mean. The most pronounced advances were recorded for Urticaceae (19 days earlier) and *Quercus* (15 days earlier), whereas the start of the Pinaceae pollen season coincided with the long-term average. The earlier onset of the pollen season in arboreal taxa was primarily associated with increased mean daily air temperatures in March and April, which reached an average of 5.1 °C, approximately 1 °C above the long-term mean (Fig. 1). In contrast, the earlier beginning of the MPS for herbaceous taxa was mainly linked to June temperatures that were 2.1 °C higher than the long-term average. Elevated temperatures after dormancy promote pollen development, resulting in accelerated maturation and an earlier initiation of pollen release (Štefániková et al. 2026).

With the exception of Cupressaceae/Taxaceae, Pinaceae and *Alnus*, the duration of the pollen season was prolonged for all dominant taxa. The most substantial extensions were observed for Poaceae (by 16 days) and Urticaceae (by 14 days). The longer pollen seasons of these taxa may be attributed to the higher total precipitation in July and August (+65.3 mm) compared with the long-term average, as adequate moisture during hot summer conditions promotes growth and supports continued flowering in both groups (Schramm et al. 2021).

Apart from *Betula*, all analysed taxa exhibited increased SPIn and peak values. These increases ranged from 44% (SPIn) and 39% (peak) in Urticaceae to as much as 334% and 328% in Cupressaceae/Taxaceae, respectively (Fig. 2). Consistent with observations from the preceding two years, *Betula* displayed a reduction in MPS intensity, with SPIn values 34% lower and peak concentrations 26% lower than the long-term mean. This decline is most likely attributable to the species' natural alternation between years of high and low pollen production (Kubík-Komar et al. 2021; Ščevková, Dušička 2024, 2025). The highest peak pollen concentration was recorded for Cupressaceae/Taxaceae (4,238 pollen/m³), whereas the lowest peak value was observed for Poaceae (161 pollen/m³).

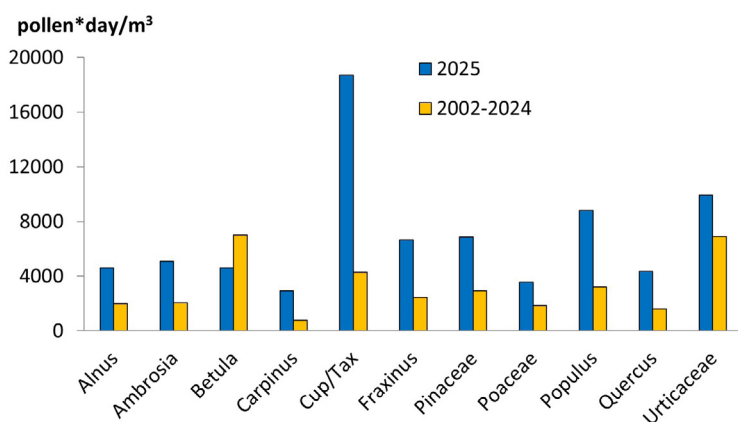


Fig. 2. SPIn of the dominant pollen types in the air of Bratislava

Obr. 2. SPIn dominantne zastúpených typov peľových zŕn v ovzduší Bratislavy

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Abstrakt

V roku 2025 bolo v ovzduší Bratislavy zaznamenaných celkovo 91 465 peľových zŕn, čo predstavuje nárast o 107 % v porovnaní s dlhodobým priemerom za roky 2002 – 2024. Najpočetnejšie boli peľové zrná *Cupressaceae/Taxaceae*, ktoré tvorili 22 % z celkovej ročnej peľovej záťaže, nasledované *Urticaceae*, *Populus*, *Pinaceae*, *Fraxinus*, *Ambrosia*, *Alnus*, *Betula*, *Quercus* a *Poaceae*, ktoré spolu predstavovali 87 % celkového počtu peľových zŕn. S výnimkou *Betula* vykázali všetky významne zastúpené taxóny zvýšenú intenzitu peľovej sezóny, čo sa prejavilo vyššími hodnotami Sezónneho peľového integrálu (SPIn) a maximálnych denných koncentrácií v porovnaní s dlhodobým priemerom. Rozsah nárastu SPIn sa medzi taxónmi líšil, od +44 % u *Urticaceae* až po +334 % u *Cupressaceae/Taxaceae*. U dominantne zastúpených taxónov boli zaznamenané aj posuny v načasovaní ich peľových sezón. U väčšiny taxónov (s výnimkou *Pinaceae*) peľová sezóna začínala skôr, pričom najväčší posun bol zaznamenaný pre *Urticaceae* (o 19 dní skôr) a *Quercus* (o 15 dní skôr). S výnimkou *Cupressaceae/Taxaceae*, *Pinaceae* a *Alnus* sa peľové sezóny predžili, a to až o 16 dní v prípade *Poaceae*. Naopak, peľová sezóna *Cupressaceae/Taxaceae* sa napriek zvýšenému SPIn skrátila o 6 dní.

Kľúčové slová: sezónna dynamika peľu, fenológia peľu, meteorologické faktory