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AIRBORNE POLLEN OF *OLEA* IN FIVE REGIONS OF PORTUGAL

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Ribeiro H, Cunha M, Abreu I: Airborne pollen of *Olea* in five regions of Portugal. *Ann Agric Environ Med* 2005, **12**, 317–320.

Abstract: The aim of this work was to study spatial and temporal distribution of *Olea europeae* airborne pollen in different Portuguese regions: Reguengos de Monsaraz (south); Bairrada (west); Braga (northwest); Valença do Douro and Foz Côa (north-east). Airborne pollen sampling was conducted from 1998–2003 using "Cour" type samplers located in each region. The main pollen season (MPS) of *Olea* lasted on average 36 days and occurred from late April until middle-to-end of June. During the studied period, inter-annual variations among and within regions, concerning the total annual pollen counts and the beginning, peak and ending dates of the MPS, were reported. Reguengos de Monsaraz and Bairrada registered the earliest MPS starting date, followed by Valença do Douro and Foz-Côa, and the latest date was verified in Braga that also had the shortest MPS. Reguengos de Monsaraz presented the longest MPS with the highest differences in the beginning and ending dates, but minimum differences in the dates of the maximum pollen peak. Our results showed an increase in the *Olea* annual pollen index, from north to south, and from the west to the east regions of the country.

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INTRODUCTION

The atmospheric concentration of different pollen types, and the start and duration of the pollen season vary enormously within regions of the same country because pollen emission is dependent on vegetation and environmental conditions.

Knowledge of olive tree phenology could greatly enhance a grower's ability to plan management practices in relation to the events occurring within the tree. Aerobiological data have been commonly used as a phenological tool for predicting the beginning of the pollination period, for crop forecasting [5], and even as an indicator of global climatic changes [14].

The monitoring of airborne pollen of plants of economic significance, such as vineyard [3] and olives [6, 8] has received increasing attention in recent years.

Olive growing marks a significant land use in Portugal, with important environmental, social and economic implications, occupying around 0.5 million ha. Being one of the main important activities in the Portuguese agriculture, it is well adjusted to the edafoclimatic characteristics of our country. Due to this abundance of olive crop, its pollen is one of the most important airborne pollen types in the Mediterranean region [10].

At the present time, no aerobiological study comparing the *Olea* flowering season and concentration of pollen grains throughout Portugal has been performed.

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In order to contribute to the study of the behaviour of *Olea* flowering season and its variability throughout Portugal, *Olea* main pollen season (MPS) has been monitored by us over the last 6 years.

The aim of this work was to study the spatial and temporal differences observed in the *Olea europaea* atmosphere pollen distribution in 5 Portuguese regions.

MATERIAL AND METHODS

Airborne pollen sampling was performed in 5 Portuguese regions: Reguengos de Monsaraz (REM: 38º0'N, 7º51'W) in the Alentejo; Bairrada (BAI: 40º26'N, 8º26'W) in Beira Litoral; Braga (BRA: 41º33'N, 8º24'W) in Minho and Valença do Douro (VAD: 41º08'N, 7º33'W) and Foz Côa (FOC: 41º0'N, 7º26´W) in Douro region. The climate of all studied regions is Mediterranean, with a relatively mild temperature. Douro region has an evident continental influence, with marked annual thermal contrast, while Bairrada and Braga are affected by an Atlantic influence. The Alentejo region is characterised by a mesomediterranean environment without any relief feature. The sampling was conducted from 1998–2003, using Cour collectors, located in each region approximately 15–20 m above ground level. The location of the samplers was chosen according to an analysis of the region's topography and direction of the dominant winds during the flowering period. In these sampling instruments, the pollen grains are trapped on vertical gauze filters with an area of 400 cm^2, impregnated with silicone oil, and fixed vertically on a wind-vane which continually orientates the filters according to the wind. During flowering, filters were exposed for 3 or 4 days. Airborne pollen was expressed in number of pollen grains transported per m^3 of air, taking into account the air quantity measured with an Enerco 402 anemometer (Cimel® Electronics, Paris). Filter efficiency varies from 17–24% according to the wind speed; therefore, an average coefficient of 20% was used to estimate data for the analysis variables. After exposure, the pollen grains were removed using several chemical treatments, glycerol added and the identification and counting of *Olea* pollen grains carried out, independently of the pollen concentration, with 10 regular traverse rows of the light microscopic (×630) according to the standardized method described by Cour [4]. The Cour method includes the acetolysis technique, which eliminates most of the residual organic material and the cytoplasmic content of the pollen grains and facilitates its identification during the optical microscope observation [4].

The main pollen season (MPS) was defined as the number of days from the January when accumulated sum of pollen reached 1% of the annual total, and for the end of the season as the date when the accumulated sum reached 99% of the annual total pollen. Airborne pollen concentration was expressed as a Pollen Index (PI = MPS

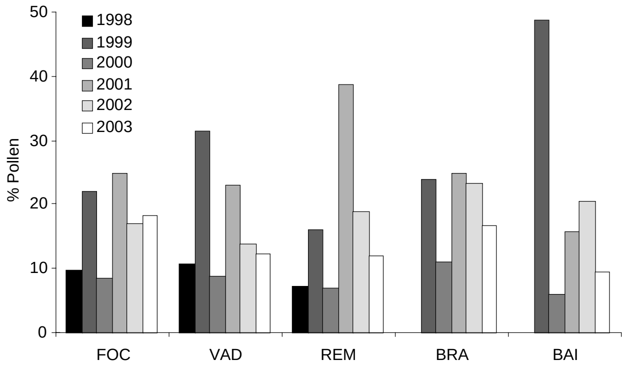

Figure 1. Annual *Olea* pollen concentration variation in the atmosphere of the 5 studied regions (FOC: Vila Nova de Foz-Côa, VAD: Valença do Douro, REM: Reguengos de Monsaraz, BRA: Braga, and BAI: Bairrada).

Table 1. Descriptive statistic of *Olea* flowering season for the 5 studied regions (dates from 1 January).

Region		Beginning date	Peak date	Ending date
Valença do Douro	Max	142	149	170
(n = 6)	Mean	132	146	167
	Min	125	138	162
	SD	6.56	4.45	4.23
	CV%	4.98	3.04	2.53
Foz-Côa	Max	142	152	173
(n = 6)	Mean	132	146	168
	Min	126	141	162
	SD	6.26	3.69	3.08
	CV%	4.74	2.53	1.35
Reguengos de Monsaraz	Max	132	138	172
(n = 6)	Mean	124	136	163
	Min	116	133	152
	SD	5.58	1.87	7.39
	CV%	4.52	1.38	4.55
Bairrada	Max	132	146	164
(n = 5)	Mean	124	139	158
	Min	119	133	155
	SD	6.14	5.34	3.90
	CV%	4.97	3.84	2.22
Braga	Max	148	163	180
(n = 5)	Mean	142	150	176
	Min	139	144	170
	SD	3.94	7.60	3.44
	CV%	2.77	5.07	2.17

n: number of sampling years, Max: maximum value, Mean: average value, Min: minimum value, SD: standard deviation, CV%: coefficient of variation.

total pollen/MPS sum pollen during sampling period 1998-2003; this index is expressed in percentage).

Descriptive statistical analysis was performed using a SPSS 11.5 software version for Windows.

RESULTS

Olea pollen is generally present in the atmosphere of Portugal from late April until the middle-to-end of June, lasting on average 36 days; the day of maximum pollen concentration recorded, on average, in the last week of May.

As regards *Olea* spatial distribution, the start of the pollination period and concentrations varied depending on the study year and different sites.

Variations of the annual pollen concentration, expressed as a PI, in the 5 sampling stations are shown in Figure 1. With respect to the magnitudes of the concentrations found, the PI was minimal in 1998 and 2000; average in 2002 and 2003; and maximal in 1999 and 2001. These latter observations were mainly due to the higher values observed in VAD and BAI (48.6%) for 1999 and in REM for 2001 (38.8%).

In the Douro region, the highest annual *Olea* PI was observed in 1999 (VAD: 31.6%; FOC: 21.9%) and the lowest in 2000 (VAD: 8.8%; FOC: 8.3%), this latter year being the one with less total *Olea* pollen concentration. It was also observed that VAD had higher PI values in the 2 first years, while FOC registered higher ones in the last 3 years of the studied period.

Braga region showed a similar PI value along the 5 year sampling, apart from 2000, with lower variations, contrary from the ones observed in BAI and REM.

Olea PI in BAI and REM presented a clear behaviour of years of increasing and decreasing concentrations, although the same was observed for the other 3 sampled regions.

Intra- and inter-annual variations of the beginning, peak and ending dates of *Olea* MPS for the 5 studied regions are indicated in Table 1. In spite of being very low, yearly variations were observed, as shown by the statistic CV (%) values.

The earliest MPS starting date was observed in REM and BAI, followed by VAD and FOC, and the latest in BRA. The maximum *Olea* PI were attained earlier at REM followed by BAI, FOC, VAD and BRA successively. Concerning the MPS ending dates, *Olea* flowering period ended first in BAI region and at last in BRA region. The longest *Olea* MPS was observed in REM and the shortest in BRA.

The lowest SD and CV (%) for the MPS beginning date were observed in BRA, while for the other 4 regions SD and CV (%) were very similar. When the different regions MPS peak SD and CV (%) were compared, REM showed the lowest values (SD = 1.87 and CV (%) = 1.38), contrary to BRA with the highest ones (SD = 7.60 and CV (%) = 5.07).

In the Douro region, some differences were also observed concerning the MPS dates. Thus, FOC presented lower CV (%) for the MPS dates when compared with VAD, in spite of very small (0.5%).

Finally, the ending dates of *Olea* MPS were less variable. The exception was observed in REM, with a CV of 4.6%. The FOC region presented the lowest variation for the MPS ending dates.

DISCUSSION

In the 5 sampling stations, the olive presented a short period of pollen emission, covering about 1 month (May–June). Compared with other Mediterranean regions, the *Olea* onset flowering dates took place slightly later than in the south of Spain [8, 15] and earlier than in Italy [13].

Inter and intra-annual differences of PI were observed in each site. The results obtained during the study period demonstrated the occurrence of an inter-annual cyclic variation of airborne pollen emission. Years of high pollen production alternated with low production ones, although in 2003 the cycles were interrupted. These variations were also observed by other authors [6, 9, 11, 12] and are related with the plant biologic cycle and its response to the climatic conditions. It is also important to notice that annual pollen emission is highly dependent on rainfall and temperature conditions during the blooming season. As was demonstrated for Braga region, the occurrence of dispersal rainfall affected the continuity of *Olea* pollen concentration [16].

The highest concentrations recorded in the Douro (VAD and FOC) and Alentejo (REM) regions, representing 66% of the total PI of the sampled sites, are mainly due to the predominance of extensive olive groves, with high pollen production. However, in REM a decrease of the airborne pollen concentration was observed which can be associated with a change in the use of the agricultural land. During recent years many olives have been replaced by vineyard.

Annual, varying magnitudes of *Olea* PI were observed, contrary to the differences observed in the MPS beginning, peak and ending dates. The timing of the start of flowering, to a large extent, is determined by climatic variables [3] and sometimes influenced by the altitudinal distribution of trees [7]. Most authors agree that temperature is one of the main factors affecting the onset of flowering in tree species which flower at the beginning of spring [1, 6, 9]. As suggested by some authors [9, 14], the *Olea* floral maturation is highly influenced by temperature in the previous years. Studies performed by other researchers [2] showed that the *Olea* flowering period occurs relatively later when compared with other flowering spring trees. *Olea* needs higher amounts of heat for the good development and maturation of the flowering buds. For this reason, the temperature inter-annual variations during the development stages of the flower buds are indicated as a determining factor in the control of the flowering phenology.

A period of dormancy with low-temperature during autumn-early winter is required for olive bud development. Once the chilling period is over, these trees start to accumulate enough hours of heat, above a threshold value, to develop the reproductive structures, and continuing until flowering starts. Knowledge of the chilling and heating needs enables us to determine the onset of pollination. Therefore, the MPS dates variability observed in our studied regions may be related not only to the different thermal regimes but also with the geographical location of each sampling region. Having as reference the meteorological series of 61/90 the highest mean temperature values were observed in REM followed by FOC, VAD, BAI, and the lowest ones were observed in BRA. These values are related with the onset of *Olea* flowering season in Portugal. Both REM and BAI are located at latitude lower than 40ºN while the other 3 regions are at latitude 41ºN. Also, in spite of the higher annual average mean temperature values observed in FOC and VAD, compared with the ones for BAI, this latter region has an important maritime influence (located at 8º 26W compared with the location of 7º 26W of FOC and 7º 33W of VAD), which attenuates lower thermal values. Therefore, in the BAI region, olives start accumulating heat earlier.

It is interesting to note the differences observed for the MPS peak and ending dates in the Douro region. The 2 sampling stations are located at different places, just a few kilometres apart, sampling pollen from different zones. An explanation for this situation probably lies in the surroundings of each sampling point.

CONCLUSIONS

This study enables the identification of the main characteristics of *Olea europaea* flowering season:

• Throughout Portugal its MPS starts, on average, around the first week of May and ends in the third week of June.

• Our results showed an increase for the *Olea* MPS beginning, peak and ending dates from the North to the South and from the West to the East of the country related with geographical and meteorological conditions. It was also observed that the biannual variability may be influenced by the meteorological conditions of the sampling sites.

It will be fundamental in near future research to statistically relate the meteorological parameters and the seasonal behaviour of olive trees in order to develop biologic models and consequently forecasts for the onset of the olive flowering season in Portugal.

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