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Phenological and aeropalynological survey in an olive orchard in Umbria (Central Italy)

MARCO FORNACIARI, FABIO ORLANDI and BRUNO ROMANO

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The olive tree *Olea europaea* L. is a resource of notable value from an economic and landscape point of view in Central Italy. This study examined two cultivars (Giarraffa and Ascolana) grown in an associative stand in an experimental olive orchard, to verify the possibility of introducing new olive cultivars into Umbria. The analyses were carried out at three different altitudes in the olive orchard following criteria used for non-homogeneous samplings in order to minimize the effect due to steepness. Since the number of trees of the two cultivars is different, the sample sizes were different for the two cultivars.

Phenological observations of the above mentioned cultivars and the evaluation of the pollen flow, done by using a portable pollen trap inside the olive orchard, were carried out over two seasons (1998–1999). The start of initial phenological phases differed in the two cultivars, but the differences became less evident during phases of anthesis. In aeropalynological respect, it appears that, in a hill species such as the olive tree, the flowering is correlated with altitude. Comparing the aeropalynological data from the distant pollen trap and those collected in the olive orchard, it is clear that the periods of pollen release are very similar in the two cultivars, and there is a clear synchronism in the peak pollen release. It is concluded that in Central Italy the pollen grains of Giarraffa cultivar are well compatible with the Ascolana cultivar from a phenological and aeropalynological point of view.

Marco Fornaciari, Fabio Orlandi & Bruno Romano, Department of Plant Biology and Agroenvironmental Biotechnology, University of Perugia, Borgo XX Giugno 74-06121 Perugia, Italy. E-mail: mfdp@unipg.it.

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In recent years, increasing attention has been paid to the monitoring of airborne pollen of plants of economic significance (Fornaciari & Romano 1993, 1994; Romano & Fornaciari 1994), not only in Umbria (Central Italy), but also in other Mediterranean regions (Dominguez et al. 1995, Recio et al. 1996, Trigo et al. 1997, Tomas et al. 1997, Belmonte et al. 1998). In our region (Umbria; Central Italy), investigations on olive microsporogenesis were carried out (Fornaciari et al. 1996), while later statistical models were prepared (Fornaciari et al. 1997, 1998a) to evaluate the events which influence the different developmental stages of the species. Phenological and aeropalynological observations (Fornaciari et al. 2000) were evaluated to estimate more accurately the starting dates of flowering, as examined by other authors (Bignami et al. 1994). The main motive for this field of research is to determine the possible relationship between anthesis and final fruit production (Fornaciari et al. 1998b, Minero et al. 1998).

In Umbria the olive tree is of great economic importance. Two olive cultivars (Ascolana and Giarraffa), known for their production-increasing qualities and introduced into Umbria to produce table olives, were studied in an experimental olive orchard for two years (1998–1999).

The present study consists of phenological investigations on the cultivars, and of an airborne pollen monitoring within the olive orchard. The aim is to show, during the flowering period, the progress of growth and development of

the olive trees characterized by selfsterility, and particularly to verify the possible use of new cultivars in an area which is known for the production of extra vergin olive oil, and characterized by its typical climatic conditions, such as late frost, which usually occurs when the pre-flowering phases are developing (April).

MATERIALS AND METHODS

The study was conducted in an experimental olive orchard (Azienda Agricola FAENA s.s.) located on a steep hillside near the Agricultural Faculty of Perugia. The orchard, planted in 1983, covers about 2.00 hectares wide and hosts 990 trees of two cultivars (Ascolana, practically self-sterile, and Giarraffa, one of the possible pollinators), planted in rows (4 m × 3 m) in a 10:1 ratio. The pollen monitoring survey was carried out at three different altitudes: MAX (380 m a.s.l.), MED (375 m a.s.l.), and MIN (365 m a.s.l.), due to the steepness of the terrain.

The phenological observations were made weekly in both years from the end of March until the end of June, following to the protocol of the “Italian National Working Group on Phenology”. The protocol-tables indicate 14 vegetative phases, labeled with the letter V, and 12 reproductive phases, indicated with the letter R. Due to a greater interest in the anthesis phase, the reproductive phases were only studied up to phase R8 at the end of June. These reproductive phases are: R1=budding; R2=raceme; R3=beginning of flowering; R4=full flowering; R5=flower fading; R6=end of flowering; R7=seed-setting; and R8=ovary increase. During the period of full pollination, the phenological observations were made

every two days, in order to accurately record the development of the most important phases on the trees under observation. The phenological analyses were carried out on a sample of 60 trees of the cv. Ascolana the most numerous and on a sample of 10 trees for the cv. Giarraffa. The cv. Ascolana sample was made up of 20 trees from each of the zones corresponding to the three altimetric levels; the cv. Giarraffa sample was completely random.

The monitoring of airborne pollen was carried out every two days during the flowering period using a portable volumetric sampling instrument "Personal Sampler Burkard", which enabled us to assess the concentration of airborne pollen grains (Ogden et al. 1974). At the same time in the morning, the pollen sampling was conducted for a total of 15 minutes and was carried out at a location downwind from the pollen source. The samplings were repeated four times, mostly at each of the three altitudes, sometimes only in the upper zone considered to be the most representative for recording the concentration airborne pollen. In the course of the study, it became apparent that the lower zone of the olive orchard was affected by border phenomena because of lying at the terminal part, and that the intermediate part was influenced too much by the marked slope variation, so, the highest part turned out to be most representative of the three altitudinal zones.

The daily series of the pollen concentration counts were completed, when necessary, by using a missing values reconstruction technique named "smoothing" (Simonoff 1996), and then corrected for the principal meteorological variables of the period (temperature and rain).

General background concentrations of atmospheric olive tree pollen were recorded (24 hours a day) with a "VPPS 2000 Lanzoni" continuous volumetric pollen trap at a fixed location on the roof of the Agricultural Faculty of Perugia, at a distance of 300 metres from the olive orchard.

The meteorological data used were extrapolated from the databank of the National Agro-meteorological Network (R.A.N. – Ministry of Agriculture). The reference station is located a few kilometres from the experimental olive grove at 229 m a.s.l. The meteorological variables used were: temperature (°C min and max), precipitation (mm of rainfall), relative humidity (%) and sunlight (minutes). To interpret the results, the average values for each parameter were calculated using data collected in five-day periods.

RESULTS AND DISCUSSION

The phenological investigations, carried out at the beginning of the growing season in both years, showed a difference between the two cultivars with respect to the timing of the developmental phases. The progress of the main phases of the reproductive organs: from the appearance of the floral buds (R1) until the phase of ovary increase and fruit formation (R8) is shown in Fig. 1. The initial budding phase of cv. Giarraffa occurred at the end of March in 1998, and at the beginning of April in 1999; cv. Ascolana showed the initial budding phase on the 5th of April in 1998, and the 14th of April in 1999. The delayed bud initiation in cv. Ascolana with respect to cv. Giarraffa was recorded in 1998 and in 1999, but the differences decreased in the subsequent growing phases until the end of the cycle.

The observations carried out for the pre-anthesis and anthesis phases (R3-R4-R5) from the end of May until the beginning of June, revealed a synchronism between the two cultivars in both years. In 1998, phases R3 and R5 were

almost simultaneous, while for phase R4 (full flowering) there was only three days difference. In 1999 were separated the same phases in the two cultivars differed by only 3–4 days, with a minimal difference of just 1 day for the maximum pollen emission.

An analysis of the climatic conditions during the two-year study period can help explain the succession of reproductive phases. In 1999, cold weather until the end of April delayed the regular development of the phenological phases, although the subsequent period was marked by higher temperatures, which enhanced pollen maturation resulting in a full pollination phase in almost the same period as in the preceding year. The phenological study also showed that all the phases follow each other with a similar pattern in both cultivars. This was true even considering the fact that the first phase, apart from being the longest, may play a dominant and decisive role in the relationship between the time lead and the risk of frost damage to the new floral buds.

The possible relationship between the first early phases of development of the two cultivars in 1998 (compared with 1999) and the trends of the meteorological variables was considered. The values of the temperature minima and solar radiation (sunlight) during the two years of study are reported in Fig. 2. It is evident that the higher temperature values particularly during the first 10-day period of April 1999, are correlated to an earlier development, while the prevalence of the sunlight variable is evident from the end of March until the end of April.

The comparison between the pollen monitoring results at the three altitude levels within the olive orchard, shows the minimum statistic coefficient of variation (C.V.), in relation to the pollen recorded, in the highest zone (Table I). This result supports the decision to monitor the whole period of pollen emission in the highest zone, while including some samples in the two other zones (medium, low) but only during the full flowering period.

Airborne pollen concentration values, as recorded with the portable pollen sampler located at the orchard, show that both the peak of the pollen emission and the full flowering period occurred at nearly the same time in the two successive years (Table II). There was a marked difference in the concentration values in the two years as shown by the summation of the daily pollen concentrations (Ip). The Ip recorded in 1999 (Ip=93,675) was almost 7 times greater than in the preceding year (Ip=13,287).

The data were compared with those obtained with the fixed trap located about 300 m from the orchard. Comparing the sums of the daily pollen concentrations, it becomes clear that the difference ratios between the portable samplers and the fixed trap were the same (about 8:1) in the two years. Comparing the 1999 values of the sums of the daily concentrations recorded in the olive orchard and those measured with the fixed trap with the sum recorded in 1998 (Table II), it appears that the airborne pollen concentrations

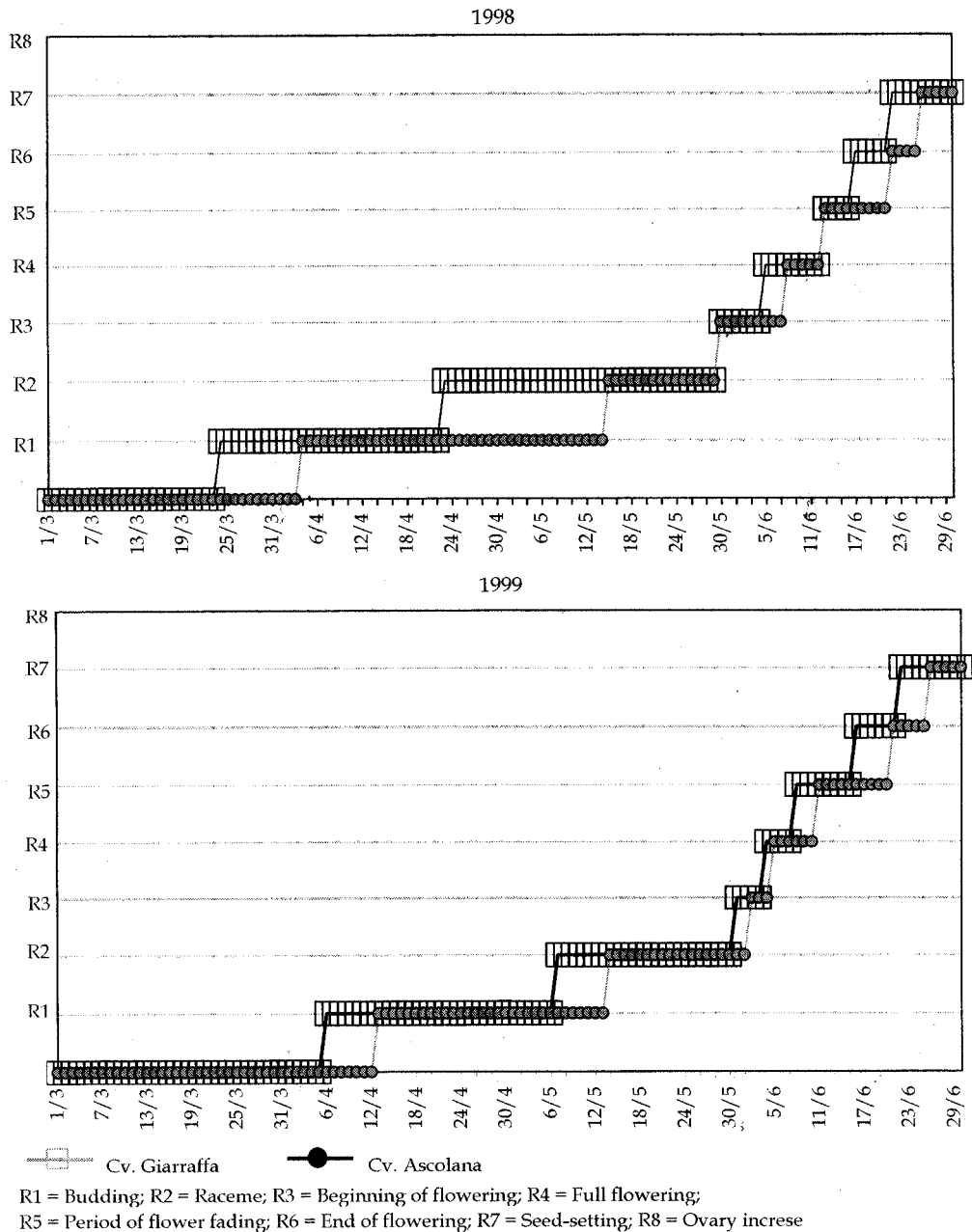


Fig. 1. Phenological phases in the two cultivars studied.

in 1998 were much lower than in 1999, at both locations, even though the ratio is almost the same.

An attempt was made to determine if the variation of the different pollen concentrations recorded during the two-year monitoring period were influenced by the differences in climatic variability, particularly during flowering time. The five-day trend values of the max and min temperatures, sunlight and relative humidity are recorded in Fig. 3. During the two years of monitoring, the flowering time ranged from the end of May to the first ten days of June and during this period temperatures were higher (particularly in the first five

days of June). This corresponded with the maximum pollen emission and with very different solar radiation emission and relative humidity trends.

The first pollen concentration peak in the orchard preceded the peak at the fixed station by one day in 1998, and two days in 1999. The duration of the pollination period, taken as consecutive days with uninterrupted pollen presence, was quite similar for the two locations, as was the period of maximum pollen concentration (9 days) (Fig. 4).

In 1998 the pollen emission started at the lowest of the three altitude levels in the orchard, followed by the

Table II. Daily airborne pollen concentrations

	1998		1999	
	Portable Sampler	Fixed Trap	Portable Sampler	Fixed Trap
25/may		9	100	2
26/may		17	400	23
27/may		4	603	42
28/may	50	1	420	34
29/may	100	4	785	41
30/may	300	4	1150	92
31/may	500	7	820	193
01/june	758	8	3597	422
02/june	1329	12	6374	600
03/june	1507	34	7500	1241
04/june	1287	74	14104	1178
05/june	2168	172	10270	1027
06/june	1110	240	11027	1355
07/june	1424	223	12500	989
08/june	1481	122	11843	964
09/june	1115	104	8722	995
10/june	188	118	2960	800
11/june	20	163	500	768
12/june		110	100	111
13/june		55		169
14/june		11		125
15/june		8		75
16/june		27		52
17/june		13		0
18/june		11		25
19/june		9		19
20/june		5		8
Σ	13287	1591	93675	11494
	Ratio 8.35		Ratio 8.15	

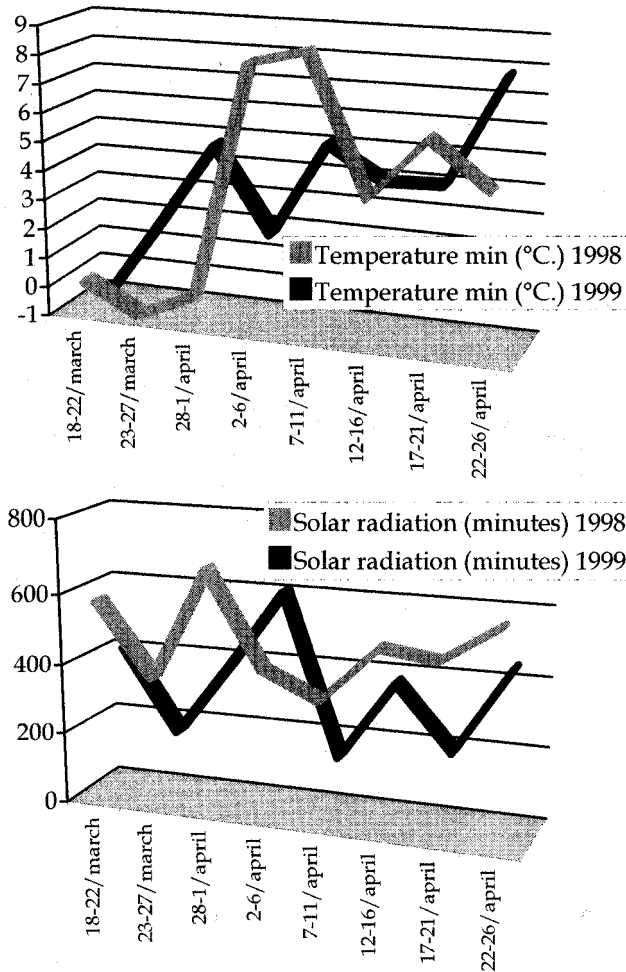


Fig. 2. Climatic variables trends in the first plant development phase.

pollination start on subsequent days at the two higher levels (Fig. 5). This was not the case in 1999, when in particular in the medium and in the lower level of olive orchard contradictory values were found during the third contemporary sampling day (7 June 1999). Although the data are

Table I. Variance within three altimetric levels of the pollen emissions recorded.

	Alt. Max	Alt. Md	Alt. Min
	(380 m a.s.l.)	(375 m a.s.l.)	(365 m a.s.l.)
1998			
04 june	1287	582	2080
05 june	2168	2539	846
07 june	1424	1450	580
08 june	1481	1146	476
C.V.	0.06	0.14	0.19
1999			
03 june	7500	18864	12000
04 june	14104	9000	3879
07 june	12500	10500	7500
08 june	8462	4760	1520
C.V.	0.07	0.14	0.18

not sufficient to draw a strong conclusion, the pollen emission data suggest a possible trend: in 1998 the peak pollen emission in the lowest zone preceded that in the two upper zones (by at least 1 day, 4 June); in 1999 the peak in the highest zone was late compared with the other two (Fig. 5).

An agronomic explanation is that there was a thermal gradient between the different zones of the olive orchard where the lowest level received more solar radiation than the others, due to the steeper, southern slope.

CONCLUSIONS

The different analyses carried out in this phase of the investigation confirm that the cv. Giarrappa is compatible pollen with cv. Ascolana, from a phenological and aeropalynological point of view. The stages of the phenological progress of the two olive cultivars, within the olive orchard, is quite closely correlated; during the most important period of the pollination process, there is an almost complete synchronism. Airborne pollen monitoring has provided some information about the variables which influence the pollination processes.

The results of this two-year study suggest the presence of a "growth contour line" which marks threshold dates when

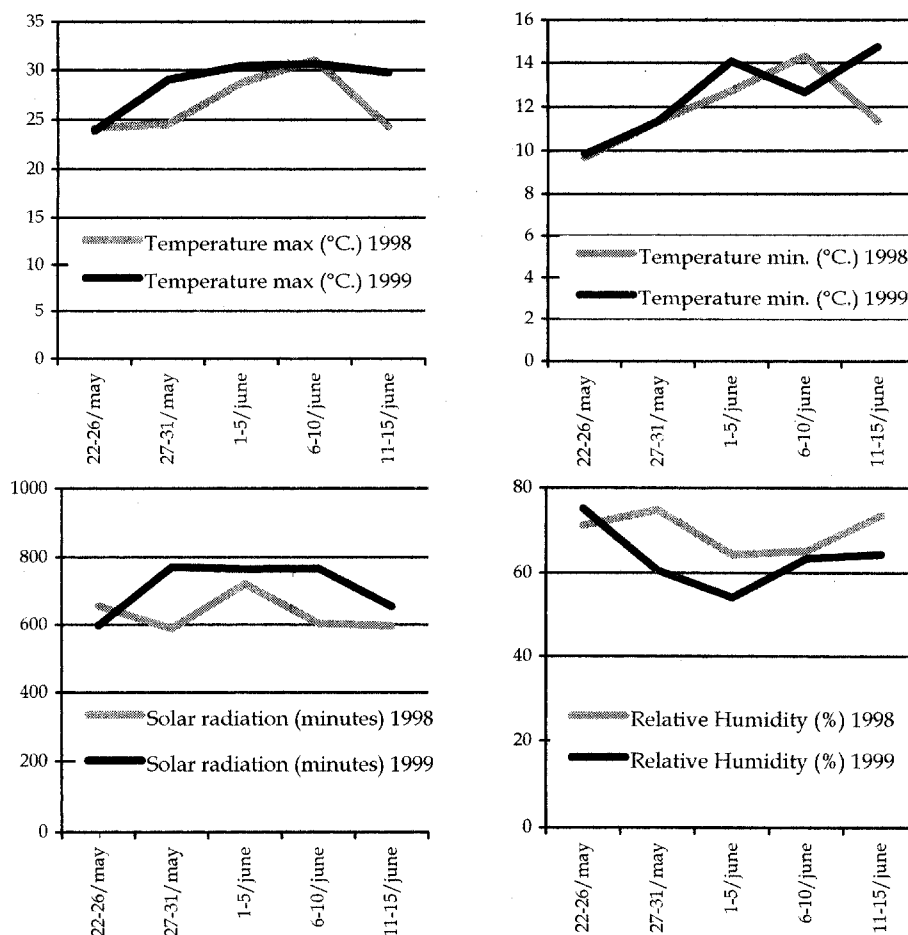


Fig. 3. Climatic variables during pollen emission period.

reproductive development in different zones will begin. In this case, the slope variation in the olive orchard influences the process of heat accumulation necessary for the development of the inflorescences (Aron 1983). In the first year, the evolution of the floral structures in the lower zone (with greater inclination) took place over a longer period of development (Fig. 1), allowing the accumulation of greater units of heat (Growing Degree Hours), while in the second year the shortening of the development period to 10–12 days reduced the accumulation differences, and consequently reduced the differences between the various zones.

Comparing the values of the climatic variables recorded during the period of pollen emissions and the pollen concentration values during the two years, suggest that the highest max temperature and sunlight values, together with the low relative humidity values recorded in 1999 could explain the high level of pollen emission. However, even though the climatic conditions cited may have contributed to making the differences in the pollen concentrations over the two-year period, the main reason must be attributed to the phenomenon of alternate production, which is typical of olive.

The differences in airborne pollen concentrations in the orchard, in comparison with those registered at the nearby fixed station were also considered. The marked difference in concentration values can be explained by the fact that the portable sampler in the olive orchard recorded the pollen emission from one source, while the fixed trap records olive anthesis from a much wider area by capturing pollen that has been transported by atmospheric currents, and thus the pollen concentration is diluted by great volumes of air. Regardless of the different properties of the two sampler systems, the recorded peak pollen values and the duration of the maximum pollen emission period coincide perfectly. Therefore, these data confirm the usefulness of volumetric pollen traps as monitoring instruments for measuring and evaluating airborne pollen emissions, concentration and flow (Nieddu et al. 1997).

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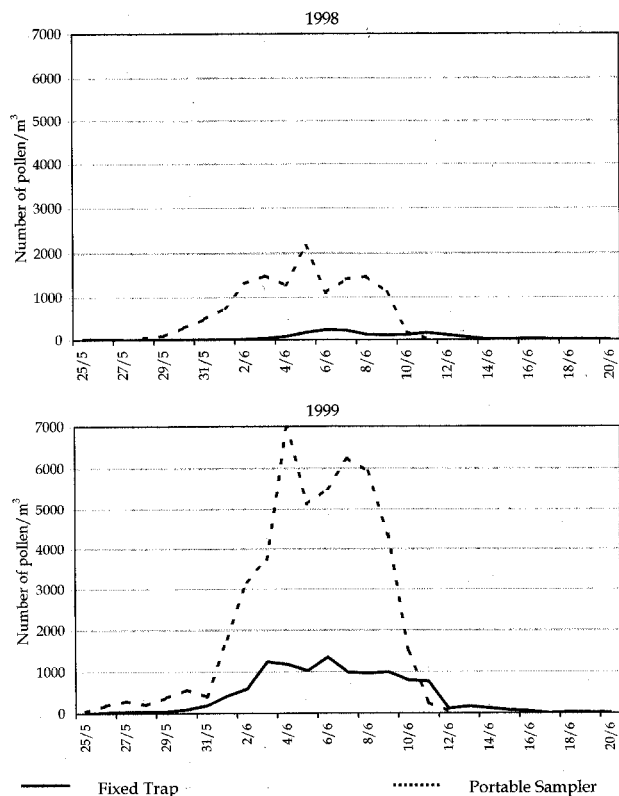


Fig. 4. Airborne pollen concentrations in the olive orchard (portable sampler) and in urban area (fixed trap), analysis realized in 1998 and 1999.

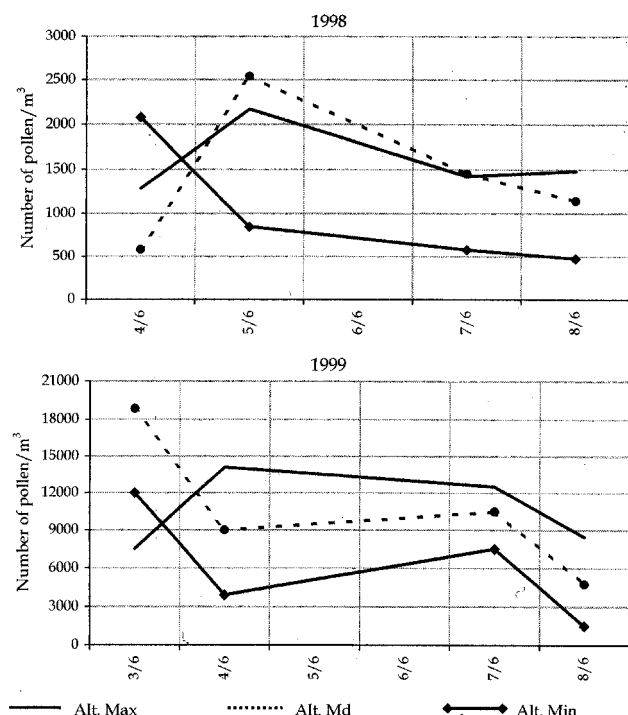


Fig. 5. Airborne pollen concentrations at various altitudes within the orchard.

REFERENCES

- Aron, R. 1983. Availability of chilling temperatures in California. – *Agricultural Meteorology* 28: 351–363.
- Belmonte, J., Roure, J. M. & March, X. 1998. Aerobiology of Vigo, North-Western Spain: atmospheric pollen spectrum and annual dynamics of the most important taxa, and their clinical importance for allergy. – *Aerobiologia* 14: 155–163.
- Bignami, C., Natali, S., Menna, C., Peruzzi, G., Lavee, S. & Klein, I. 1994. Growth and phenology of some olive cultivars in Central Italy. – *Acta Horticulturae* 356: 106–109.
- Dominguez, E., Carinanos, P., Galan, C., Guerra, F. & Garcia-Pantaleon, F. I. 1995. Airborne pollen concentrations, solid particle content in the air and allergy symptoms in Córdoba (Spain). – *Aerobiologia* 11: 129–135.
- Fornaciari, M. & Romano, B. 1993. Indagine aeropalinologica sulla pollinazione di piante di interesse economico. – *Annali della Facoltà di Agraria, Univ. Perugia* 47: 129–137.
- Fornaciari, M. & Romano, B. 1994. Il monitoraggio pollinico volumetrico in agricoltura: un biennio di osservazioni. – *Annali della Facoltà di Agraria, Univ. Perugia* 48: 115–128.
- Fornaciari, M., Ferranti, F. & Romano, B. 1996. Environmental conditions and microsporogenesis in *Olea europaea* L. (Oleaceae). – *Giornale Botanico Italiano* 130 (1): 426–430.
- Fornaciari, M., Pieroni, L., Ciuchi, P. & Romano, B. 1997. A statistical model for correlating airborne pollen grains (*Olea europaea* L.) and some meteorological parameters. – *Agricoltura Mediterranea* 127: 134–137.
- Fornaciari, M., Pieroni, L., Ciuchi, P. & Romano, B. 1998a. A regression model for the start of the pollen season in *Olea europaea* L. – *Grana* 37 (2): 110–113.
- Fornaciari, M., Pieroni, L., Rossi, A. C. & Romano, B. 1998b. Yield forecasting model for the olive. – In: 6th International Congress on Aerobiology, Perugia 1998 (ed. Org. Comm), p. 281. – Univ. Press, Perugia.
- Fornaciari, M., Galan, C., Mediavilla, A., Dominguez, E. & Romano, B. 2000. Aeropalynological and phenological study in two different olive Mediterranean areas: Cordoba (Spain) and Perugia (Italy). – *Plant Biosystems* 134 (2): 199–204.
- Minero, F. J. G., Candau, P., Morales, J. & Tomas, C. 1998. Forecasting olive crop production based on ten consecutive years of monitoring airborne pollen in Andalusia (Southern Spain). – *Agriculture Ecosystems and Environment* 69: 201–215.
- Nieddu, G., Chessa, I., Canu, A., Pellizzaro, G., Sirca, C. & Vargiu, G. 1997. Pollen emission from olive trees and concentrations of airborne pollen in an urban area of North Sardinia. – *Aerobiologia* 13: 235–242.
- Ogden, E. C., Raynor, G. S., Hayes, G. V., Lewis, D. M. & Haines, J. H. 1974. Manual for sampling airborne pollen. – Hafner Press, New York.
- Recio, M., Cabezudo, B., Trigo, M. M. & Toro, F. J. 1996. *Olea europaea* pollen in the atmosphere of Málaga (S. Spain) and its relationship with meteorological parameters. – *Grana* 35: 308–313.
- Romano, B. & Fornaciari, M. 1994. Monitoraggio pollinico di *Olea europaea* L. nell'area del Comune di Perugia nel decennio 1984–1993. – *Quaderni di Botanica Ambientale e Applicata* 3: 155–158.
- Simonoff, J. S. 1996. Smoothing methods in statistics. Ser. Statistics. – Springer, New York.
- Tomas, C., Candau, P. & Minero, F. G. 1997. A comparative study of atmospheric pollen concentrations collected with Burkard and Cour samplers, Seville (Spain), 1992–1994. – *Grana* 36: 122–128.
- Trigo, M. M., Recio, M., Toro, F. J. & Cabezudo, B. 1997. Intradurnal fluctuations in airborne pollen in Málaga (S. Spain): A quantitative method. – *Grana* 36: 39–43.