

Concentration of airborne pollen of *Vitis vinifera* L. and yield forecast: a case study at S. Michele all'Adige, Trento, Italy

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Abstract

The possibility of creating a forecast model for grape production using airborne pollen concentrations of *Vitis vinifera* L. was investigated. The study area is located in the province of Trento (46°11', 11°08'), North Italy. Because of its prestigious wine production, the area is quite important on a national scale.

Airborne pollen concentration data (P/m^3) were collected for a five year period (1993–1997) with a Hirst type sampler (VPPS 2000 – Lanzoni) following the standard methodology proposed by the Italian Aeroallergen Network. For the same five-year period, grape production data (kg/ha) from vineyards adjacent to the pollen sampler were used along with provincial data. Regression lines were constructed using the Ln of the annual sum of daily pollen concentrations (I_p) as the independent variable and grape production values as the dependent variable. Correlations between pollen data (pollen index, beginning and duration of main pollen season) and meteorological data (temperature and rainfall) are shown.

1. Introduction

Vineyards (8781 ha in 1996) occupy about 40% of Trentino agricultural land dedicated to perennial crops, with 80% of the vineyards registered as producing D.O.C. quality certified wine. The idea of estimating potential grape-harvest by aeropalynology was first developed in France at the Montpellier laboratory (Cour and Villemur, 1985; Besselat and Cour, 1990). Thanks to a 1996 European Commission project on vines and olive (Official Journal S 123 28/6/96) it quickly spread throughout Europe.

In S. Michele a/A station, instead of a Cour trap, usually adopted in this type of survey (Cour and Villemur, 1985; Besselat and Cour, 1990; Panigai and Moncomble, 1992; Minero et al., 1998), pollen is collected by means of a Hirst-type sampler which permits the determination of daily airborne pollen concentrations. The effects of temperature and rainfall on pollen behaviour are also investigated permitting the formulation of a better forecast model. The aim of this study is to examine the possibility of creating a fore-

cast model for grape production using airborne pollen concentrations of *Vitis vinifera* L.

2. Materials and methods

2.1 Study area

The town of San Michele all'Adige (pop. 2000), is located at 227 m a.s.l. in the Adige Valley, 20 km north of Trento (North Italy – 46°11'; 11°08'). The area, famous for its quality wines, accounts for half of the total provincial grape production. The climate is temperate with mean yearly temperature of 11,5 °C. Average annual rainfall of 883 mm falls in two peak periods, spring and autumn (Figure 1) (Eccel and Toller, 1996).

2.2 Pollen data

Sampling of airborne grape pollen was carried out in S. Michele a/A from 1993 to 1997 by means of a Hirst type 7-day recording volumetric spore trap (model

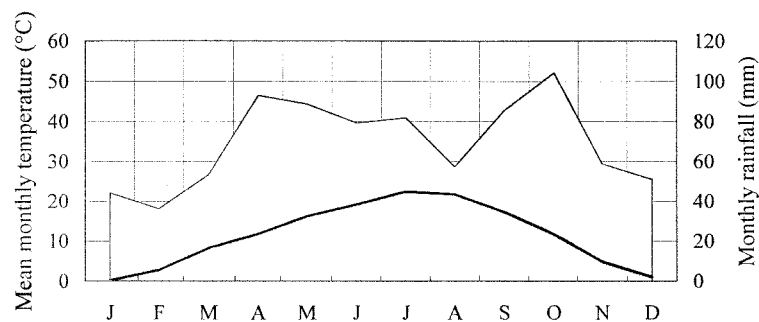


Figure 1. Mean monthly temperature and monthly rainfall for S. Michele a/A (1983–1995).

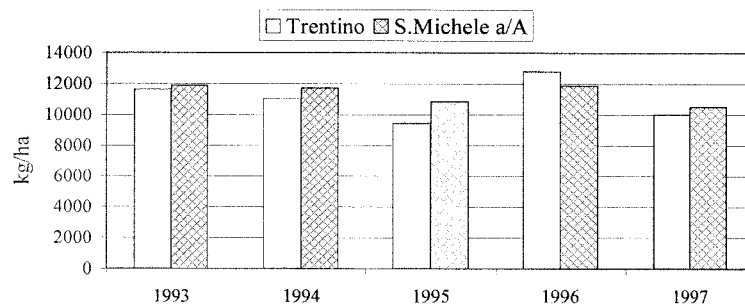


Figure 2. Variation of grape production (kg/ha) in Trentino and S. Michele a/A over the years '93–'97.

VPPS 2000 Lanzoni). The sampler, placed on the roof of a building of the Istituto Agrario at 10 m height, was calibrated for continuously sampling 10 litres of air per minute (LPM). The analysis of the airborne particles captured on the sampling surface was carried out under microscope ($400\times$) on a statistical basis, reading four horizontal continuous sweeps. This method adopted by the Italian Aeroallergen Network (Mandrioli, 1990) permits the determination of the number of pollen grains per cubic meter of air per day ($P/m^3/day$). Since it is impossible to identify grape variety by morphological pollen observation, airborne pollen concentrations are reported as *Vitis vinifera* L. (Moore et al., 1991).

2.3 Grape production

For the same five year period ('93–'97) grape production data in four vineyards of the Istituto Agrario of S. Michele a/A were collected. The choice criterion in vineyard selection took into account the proximity to the pollen sampler and the stability of the vineyards, i.e. the lack of outstanding experimental trials, common in other research vineyards of the Istituto. The grape varieties of the four plots were Chardonnay, Merlot, Cabernet and Schiava for a total surface of 3.9 hectares.

The sum of the four vineyards' production was used. Provincial grape production data were also used to verify the possibility of extending production forecasting on a larger scale (Figure 2).

2.4 Meteorological data

Daily values of air temperature ($^{\circ}C$) and precipitation (mm) from "Spartac-type" station located at S. Michele all'Adige were provided by the Provincial Agro Meteorological Centre. For every year, mean temperatures for January, February, March, April, 16th March–15th May and main pollen season were calculated. For this last period mean of maximum temperature were also calculated. Total rainfall for April, May and main pollen season were considered for each year.

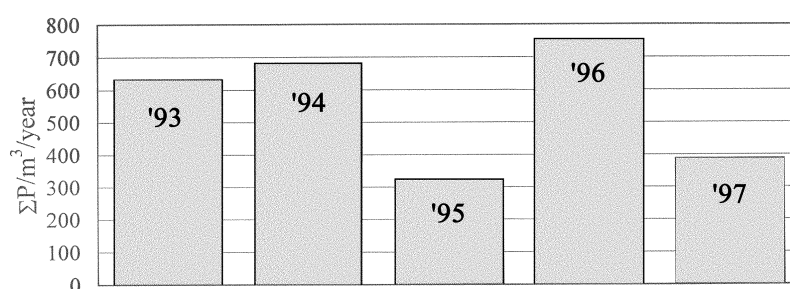
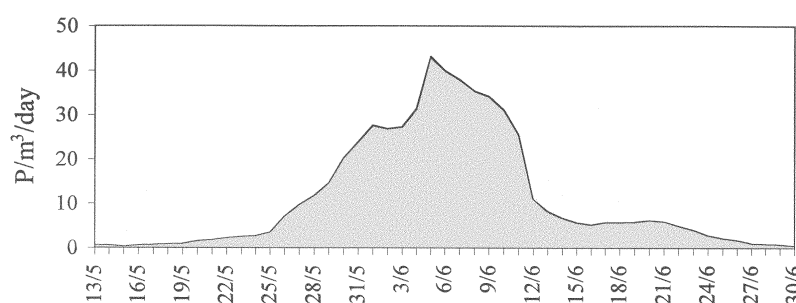
3. Results

3.1 Pollen data

For each year, the main pollen season (MPS) was calculated considering 90% of the total recorded concentrations (Table 1). Start and end dates were set to

Table 1. Main pollen seasons (m.p.s.) for *Vitis vinifera* L. over the years '93–'98.

Year	Date of start	Days from 1st January	Peak conc. (P/m ³)	Date of peak	Date of end	Duration (days)	Pollen Index ($\Sigma P/m^3/year$)
1993	27 May	147	92.6	06 Jun	11 Jun	16	633.0
1994	25 May	145	197.5	04 Jun	13 Jun	20	682.1
1995	01 Jun	152	41.5	21 Jun	29 Jun	29	325.5
1996	02 Jun	154	134.5	12 Jun	14 Jun	12	755.5
1997	23 May	143	60.5	27 May	13 Jun	22	387.5

Figure 3. Yearly sums of *Vitis vinifera* L. pollen concentrations over the years '93–'97.Figure 4. Pollen calendar of *Vitis vinifera* L. (7-day running mean) registered at S. Michele a/A from 1993 to 1997.

correspond to the days when 5 and 95% of the season's total pollen concentration were found (Nilsson and Persson, 1981). The duration of the main pollen season ranged between 12 days in 1996 and 29 days in 1995.

Pollen index (Ip) is the annual sum of the daily pollen concentrations ($\Sigma P/m^3/year$) (Fornaciari et al., 1998) and during the five considered years varies considerably from 325,5 in 1995 to 755,5 in 1996 (Figure 3).

The pollen calendar was constructed by first centering the yearly curves on the mean peak data (8th June). The five years average was calculated and then smoothed using the moving average method (7 days) (Figure 4) (Roger, 1997). *V. vinifera* pollen emission

starts around the middle of May and extends to the end of June.

3.2 Statistical analysis

Linear regression analysis was performed, assuming Ln Pollen index ($\Sigma P/m^3/year$) as the independent x variable and grape production of S. Michele a/A (kg/ha) as the dependent y variable; linear regression line was plotted. A highly positive correlation exists between these two parameters ($r = 0,922$; $P < 0,03$) (Figure 5).

Using the provincial grape production as the dependent y variable, the correlation is also significant ($r = 0,919$; $P < 0,03$) (Figure 6).

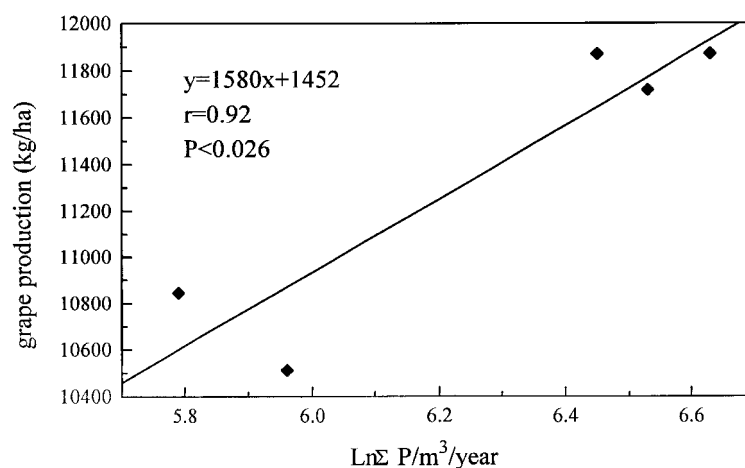


Figure 5. Linear regression between grape production and Ln Ip of S. Michele a/A over the years '93-'97.

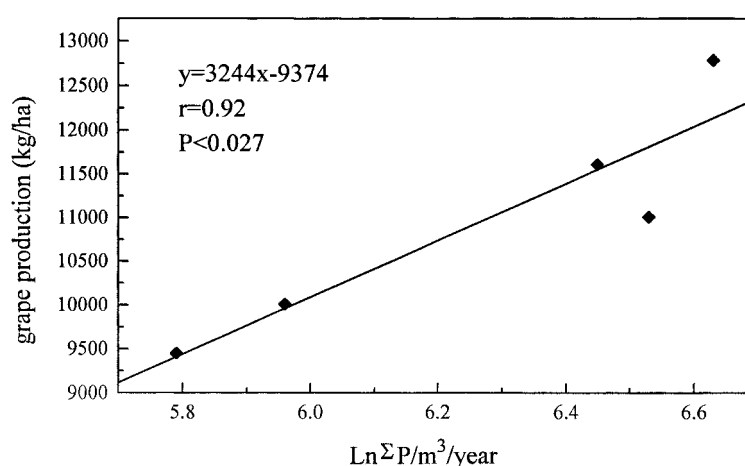


Figure 6. Linear regression between grape production and Ln Ip of Trentino over the years '93-'97.

In Table 2 it is possible to observe other significant correlations, particularly between:

- main pollen season duration (DuMPS) and mean of the maximum temperature registered during the main pollen season (TmaMPS) ($r = -0,807$; $P < 0,1$);
- main pollen season duration (DuMPS) and total rainfall registered during the main pollen season (RaMPS) ($r = 0,989$; $P < 0,005$);
- pollen index (Ip) and total rainfall registered during the main pollen season (RaMPS) ($r = -0,911$; $P < 0,05$);
- pollen index (Ip) and mean February temperature (TmeFeb) ($r = -0,904$; $P < 0,05$);
- start of main pollen season (BeMPS) and mean temperature registered during the previous pol-

ination period (TmeMar-May) ($r = 0,884$; $P < 0,05$);

- start of main pollen season (BeMPS) and mean April temperature (TmeApr) ($r = 0,943$; $P < 0,02$);
- start of main pollen season (BeMPS) and total May rainfall (RaMay) ($r = 0,806$; $P < 0,1$).

4. Discussion

The strong correlation observed between Ip and grape production permits the creation of a local production forecast model and its extension to a provincial scale. In order to improve this model, it is useful to reconsider those meteorological parameters that are most significant. In particular, rainfall during the main pol-

Table 2. Simple correlation matrix.

	TmeJan	TmeFeb	TmeMar	TmeApr	TmeMar–May	TmeMPS	TmaMPS	RaApr	RaMay	RaMay–Jun	RaMPS
Ip	0.614	–0.904	–0.090	–0.066	–0.110	0.543	0.576	0.130	–0.012	–0.705	–0.911
BeMPS	0.018	0.157	–0.787	0.943	0.884	0.650	0.597	–0.460	0.806	0.215	–0.051
DuMPS	–0.963	0.798	0.054	–0.084	–0.101	–0.770	–0.807	0.274	0.019	0.902	0.989

Ip = Pollen Index ($\Sigma P/m^3/\text{year}$)

BeMPS = Number of days from the 1st January to the beginning of the Main Pollen Season

DuMPS = Duration of Main Pollen Season (days)

TmeJan = Mean January air temperature ($^{\circ}\text{C}$)

TmeFeb = Mean February air temperature ($^{\circ}\text{C}$)

TmeMar = Mean March air temperature ($^{\circ}\text{C}$)

TmeApr = Mean April air temperature ($^{\circ}\text{C}$)

TmMar–May = Mean air temperature recorded from the 16th of March to the 15th of May ($^{\circ}\text{C}$)

TmeMPS = Mean air temperature recorded during the Main Pollen Season ($^{\circ}\text{C}$)

TmaMPS = Mean of the maximum air temperature registered during the Main Pollen Season ($^{\circ}\text{C}$)

RaApr = Total amount of rain in April (mm)

RaMay = Total amount of rain in May (mm)

RaMay–Jun = Total amount of rain registered from 16th May to 15th June

RaMPS = Total amount of rain recorded during the Main Pollen Season (mm)

len season influences the seasons duration by protracting it and reducing the Ip. This explains the washing effect from rain that drags pollen to the ground (Fornaciari et al., 1998). The duration of the pollen season is also influenced by the mean January temperature and by the maximum temperature of the pollen season. Temperature in the period immediately preceding pollination as well as rainfall in May negatively influence the beginning of the pollen season. This confirms what Fornaciari et al. (1998) observed about olive: anthesis is anticipated in presence of low levels of rainfall.

Local grape production is geared to obtaining high quality D.O.C. wine with production levels that do not exceed the threshold value according to the law. Agronomic practices also aim at standardising production by means of frequent vine control, manuring, irrigation and, if necessary, grape thinning; yearly production fluctuation depends mostly on critical meteorological situations that occur near the harvest period.

The predictive value of the regression line between pollen and grape production will be verified in the future and augmented with data on post-flowering events. It will be also possible to evaluate airborne pollen viability and its influence of grape production.

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