



A method to control the spread of allergenic pollen in archaeological and highly frequented areas

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Received 27 February 2002; accepted in final form 29 August 2003

Key words: aerobiological monitoring, allergen, archaeological areas, herbicide, infesting plant, pollen, pollinosis

Abstract

Monuments and archaeological areas are often colonized by infesting plants, many of which produce allergenic pollen that can cause allergic symptoms in sensitive subjects.

Pollen monitoring was carried out by a portable volumetric spore trap in some Roman archaeological areas and in two small cities in Latium (Central Italy), before and after a chemical treatment to eradicate infesting plants of *Parietaria* spp. to control the quality of the air.

Results indicate that the herbicide treatment reduced the presence of *Parietaria* plants and their pollen concentration in the air in the sites which were the subject of this study.

1. Introduction

Visits and promenades in archaeological areas and near old monuments are often made unpleasant by the presence of infesting plants, such as *Parietaria* sp., *Urtica* sp., *Mercurialis* sp., *Plantago* sp. and others (Blasi and Pignatti, 1984; Ceschin and Caneva, 2001), which settle on walls or hard packed soils. These plants can damage the monuments with their roots (Grilli Caiola et al., 1989), produce an accumulation of waste, and many of them also produce allergenic pollen that can cause allergic symptoms in sensitive subjects. In particular *Parietaria* at the latitude of Rome grows up and blossoms throughout the year, with a principal peak of pollination during spring and early summer, from March to July and a secondary one in autumn.

In several sites the eradication of infesting plants is carried out by mechanical mowing. This technique employs several workmen, requires days of work, with the result that it is very expensive. It is also noisy and dangerous. Infesting plants often colonize in sites difficult to reach with the mechanical bush cutters, so it is difficult to eradicate them. Besides, incomplete

eradication allows the weeds to grow up again quickly even during the same season.

A model was set up to verify the reduction of pollen concentration in the air after the eradication of allergenic infesting plants using a chemical product in order to obtain a better quality of air and improve the enjoyment of those areas. This approach has already been used in previous studies focused on the conservation of monuments (Caneva et al., 1989).

The present paper reports a decrease of pollen concentration in the air of a restricted area, through aerobiological monitoring before and after the chemical treatment. This preliminary study relates to the Urticaceae family, which includes some of the most allergenic plants growing in the sites of interest (*Parietaria* sp., *Urtica* sp.).

2. Materials and methods

After inspection of spontaneous vegetation in several archaeological sites, five of these sites were identified for Urticaceae pollen monitoring and chemical treatment on allergenic plants, as reported in Table 1.

Table 1. Chosen sites for Urticaceae pollen monitoring and chemical treatments, and length of monitoring periods.

Table 1	Weeks of monitoring	Monitoring days each week	Monitoring hours each day
1 Rome, Piazza della Consolazione	11	3	6
2 Rome, Foro di Augusto	11	3	6
3 Artena (Rome)	7	1	2
4 Minturno (Latina)	7	2	2
5 Archaeological area of Minturno (Latina)	7	2	2

The choice of the sites was subjected to the verification that endangered and protected plants were absent. The differing length of the monitoring periods were dependant on the availability of resources.

Figure 1 shows the geographical positions of the five sites included in the present study.

Piazza della Consolazione is a square in the center of Rome, surrounded by boundary walls and by the Catholic Church of S. Maria della Consolazione. The place contains a car park. It is under the Campidoglio hill and many tourists cross it to reach the Roman Forum.

Foro di Augusto is an archaeological area near Colonna Traiana and Mercati Traianei. The Roman Forum is visited by about a million tourists every year, meanwhile Foro di Augusto is visited by about 300000 tourists a year. Artena is an attractive small town in southern Latium, located at 350 m above sea level. Its historical centre is completely pedestrian. There are old palaces and ancient walls on which *Parietaria* grows abundantly. Minturno is a small town near Latina: not far from it, there is an important archaeological area with a small amphitheatre.

A well-known herbicide composed of glyphosate diluted in water was used to eradicate Urticaceae.

The chemical treatments were carried out by AMA (Municipal Agency for the environment) in Piazza della Consolazione and by GEI (a private agency for environment treatment) in the other sites, in compliance with amounts and modality advised by the manufacturer, and according to the safety rules for workmen and other people. Glyphosate is a chemical product, an organophosphate like many other herbicides but it does not affect the nervous system as other organophosphates do, so it is safe for humans and animals (Weed Science Society of America). It is a broad spectrum non-selective herbicide that kills all plants, including grasses, broad leaf and woody plants. It acts by inhibiting the shikimic acid pathway. Glyphosate is



Figure 1. Map of Latium with the five sites.

absorbed through the leaves and transported to the root apparatus where it explicates its toxic effects seven to 14 days after the application depending on the concentration used (Malik et al., 1989; Smith and Oehme, 1992). However, treated plants interrupt their growth as soon as the herbicide is applied. At low levels of application glyphosate acts as a growth regulator. After application, it is quickly degraded, so it does not pollute the surrounding environment (Carlisle and Trevors, 1988).

The monitoring of Urticaceae pollen was carried out from April to June 2001, by means of VPPS 1000 by Lanzoni, a portable volumetric trap (Hirst, 1952), located at about 1.5 meters above the ground. The trap consists of a vacuum pump that sucks air at the flow rate of 10 l/min, and through an orifice of known dimension (14×2 mm), it collects air on a microscope slide, coated with silicone. The slide moves down at 2 mm/hour, and the silicone captures the solid particles that impact on it. At the end of the exposure the slide

is treated with a basic fuchsin solution, which colors only pollen grains, and observed at light microscope using a magnification of 400X (Mandrioli et al., 1998).

Parietaria and *Urtica* grains were identified and counted, and the count was converted as an hourly concentration ($\text{P}\cdot\text{m}^{-3}\text{h}^{-1}$) (Mandrioli, 1994). Both monitoring and herbicide treatments were carried out on dry and calm days, during the first hours of the morning, from 8 am to 2 pm, which are the maximum pollination hours of the day for Urticaceae. The herbicide treatments were extended to the whole visible area covered by *Parietaria* plants, in the five sites included in the study: the walls surrounding Piazza della Consolazione, all the archaeological ruins of Foro di Augusto and the surrounding walls, the whole city of Minturno and Ardena, and all the archaeological area of Minturno.

3. Results

3.1 Rome, Piazza della Consolazione

In Piazza della Consolazione the walls surrounding the square were covered by abundant vegetation of *Parietaria*. In this site pollen monitoring began on April 7th 2001. *Parietaria* pollen concentration increased during the spring. Recorded concentration during April reached $500 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$, while in May the concentrations were higher, up to the maximum peak of $3157 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$.

On June 7th and 8th two herbicide treatments were carried out. After the treatments the plants of *Parietaria* of the whole Piazza della Consolazione were completely dead, and the recorded pollen concentration had fallen to values of about $30 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$ since June 12th (Figure 2).

3.2 Rome, Foro di Augusto

At the site of Foro di Augusto pollen monitoring began on April 7th 2001. In this area, the Urticaceae pollen concentration reached values of $135 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$. On May 25th the first herbicide treatment was carried out. Two other treatments followed, one a week. After the first treatment pollen concentration decreased to $20 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$, reaching values of $8\text{--}10 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$ after the last application (Figure 3).

3.3 Ardena

In the city of Ardena pollen monitoring began on April 12th 2001. Very high pollen concentrations were immediately recorded, with maximum peaks of $4000 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$. On April 26th, 27th and 30th three herbicide treatments were carried out. On May 2nd the pollen concentration reached almost $9000 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$, followed by lower values down to $200 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$ at the end of the monitoring (Figure 4).

3.4 Minturno

In the city of Minturno, pollen monitoring began on April 6th 2001, when pollen concentration of about $1000 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$ was registered. On April 18th and 19th two treatments were carried out. On April 21st pollen concentration was about $1300 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$, on April 29th and May 5th it diminished to $80 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$, but on May 17th it was very high again, with a peak of $1000 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$. Four other treatments were carried out and the following monitorings showed concentration values of about $20 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$ (Figure 5).

3.5 Archaeological areas of Minturno

In the site of the Archaeological area of Minturno pollen monitoring began on April 6th 2001, at the same time as the first herbicide treatment. In the following days, the pollen concentration increased, from 7 to $165 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$. Five treatments were carried out, two a month. After the last treatment pollen concentrations were about $15 \text{ P}\cdot\text{m}^{-3}\text{h}^{-1}$ (Figure 6).

4. Discussion and conclusion

This preliminary study was carried out in order to establish a simple and cheap protocol to verify the efficiency of herbicide treatment on allergenic plants, by monitoring of pollen at archaeological sites and restricted highly frequented urban areas.

The simple observation of the absence of plants in an area does not give the certainty of the absence of pollen, in fact pollen grains can reach the treated areas from surrounding emission sites. The monitoring of pollen also permits the evaluation of the pollution due to surrounding emissions.

The initial conditions at the five sites were not identical. In Piazza della Consolazione and in Foro

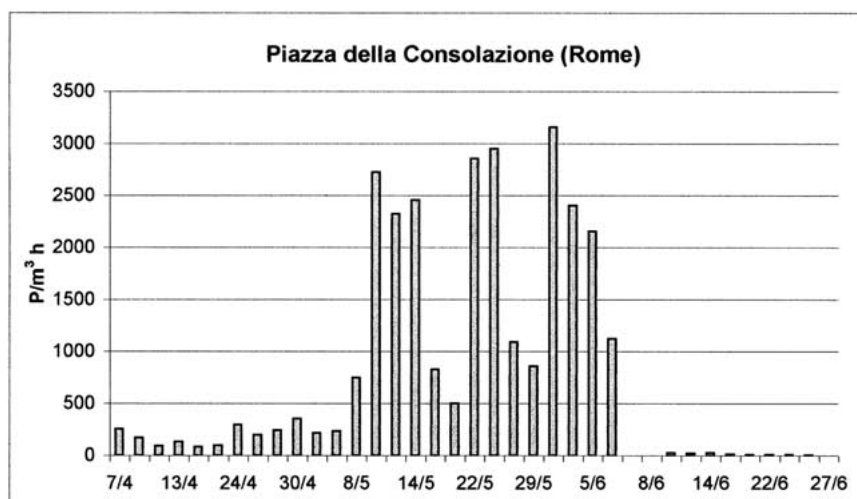


Figure 2. Trend of hourly pollen concentration before and after the chemical treatments in Piazza della Consolazione (Rome).

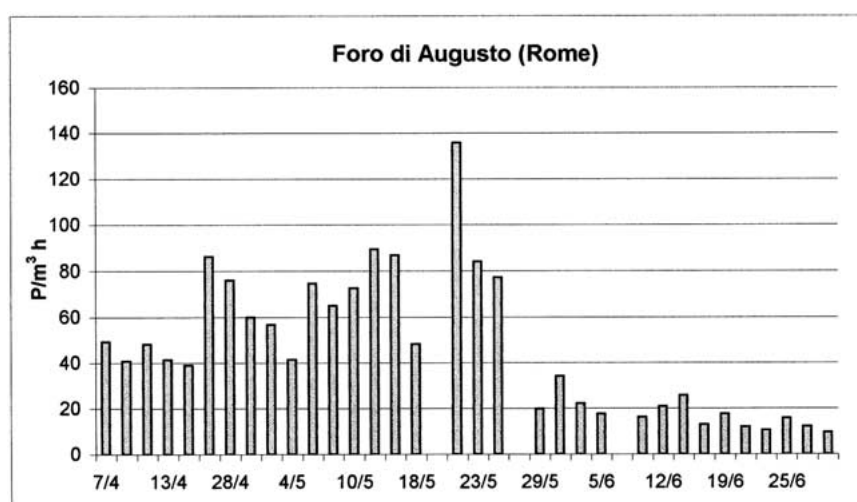


Figure 3. Trend of hourly pollen concentration before and after the chemical treatments in Foro di Augusto (Rome).

di Augusto the monitoring was carried out for many hours a day and for many days a week, while at other sites the monitoring was limited by the availability of human and economic resources.

In the five sites considered different trends were observed.

Piazza della Consolazione was the first treatment carried out, and the walls surrounding the square were covered by abundant vegetation of *Parietaria*. The pollen count reached maximum values of about $3000 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$. After two treatments, the plants of *Parietaria* on all the walls of Piazza della Consolazione were completely dead, as the pollen monitoring confirmed, recording values of about $20 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$.

In the station of Foro di Augusto the conditions were different because a herbicide treatment was carried out the previous year, and the maximum concentration value reached was only $135 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$. Nevertheless the monitoring method is sensitive enough to permit the observation of a further decrease of pollen concentration after the treatments carried out during this study.

In the site of Artena, a high peak of concentration was recorded after the herbicide treatments, followed by a decrease to low values ($200 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$). In spite of the fact that the monitoring days carried out in Artena were few, because of the lack of human resources, the results can be compared to the

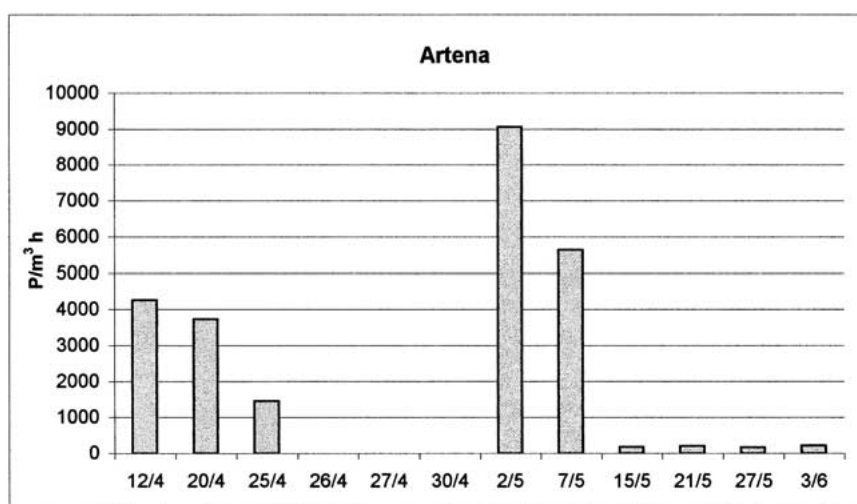


Figure 4. Trend of hourly pollen concentration before and after the chemical treatments in Artena (Rome).

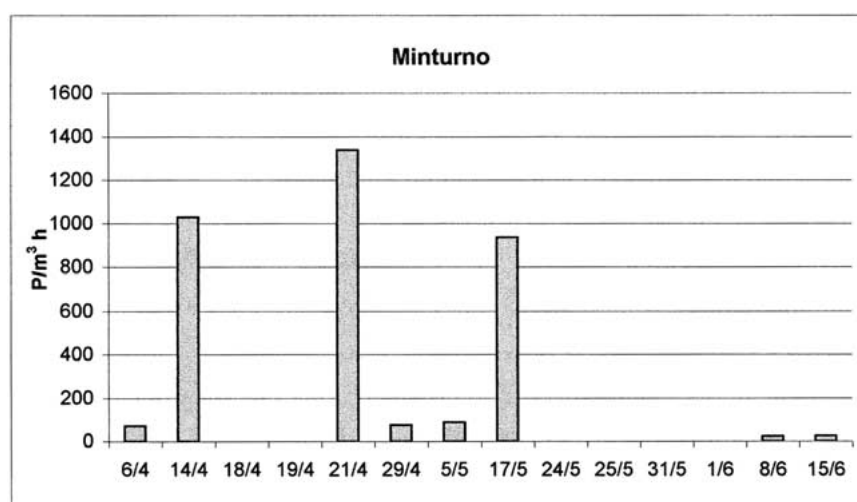


Figure 5. Trend of hourly pollen concentration before and after the chemical treatments in Minturno (Latina).

Roman ones: before the chemical treatments there was a great amount of *Parietaria* plants on the walls of the city and *Parietaria* pollen in the air, after the chemical treatments *Parietaria* plants were dead and the concentration of pollen in the air was lower.

At the site of Minturno, the pollen monitoring after the herbicide treatments showed that they did not affect the whole city. In fact some streets were not treated and there were still many plants of *Parietaria* evidenced by the unexpected peak of pollen concentration on 17th May ($\sim 1000 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$). After another four treatments, pollen concentration reached values of about $20 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$.

In the archaeological area of Minturno, the four treatments brought pollen concentration to very low levels ($15 \text{ P} \cdot \text{m}^{-3} \text{h}^{-1}$).

The results obtained suggest that the pollen monitoring in restricted areas measures the effective decrease of the pollen count in the air after the herbicide treatments. Even if in the neighbourhood of treated sites an abundant presence of *Parietaria* plants was observed, pollen spread by those plants was not responsible for the consistent increase in the concentration in studied areas. A complete treatment with glyphosate can eradicate the plants covered by this study; consequently the concentration of pollen in the air in the treated areas decreases, and this can lead to

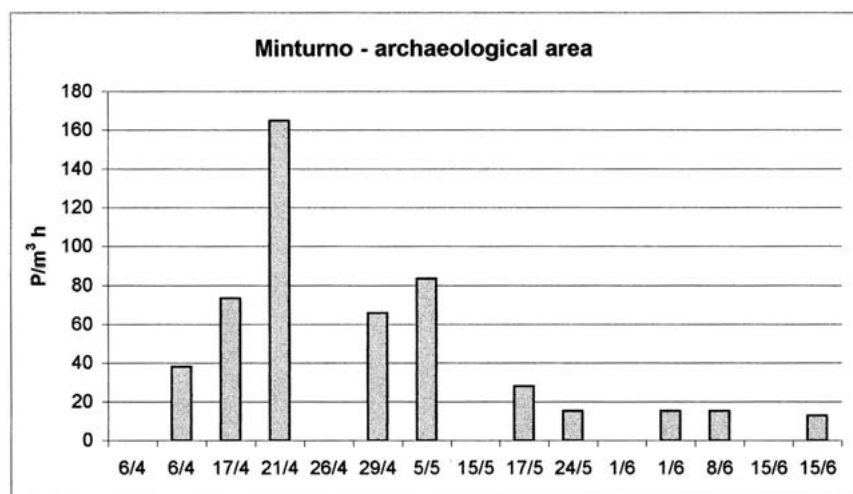


Figure 6. Trend of hourly pollen concentration before and after the chemical treatments in the archaeological area of Minturno (Latina).

better air quality and conservation of archaeological sites and monuments.

The proposed method of control of the dispersion of allergenic pollen is valid to demonstrate the reduction of pollen concentration after the herbicide treatment. Therefore it can be used in the archaeological areas and the highly frequented squares and villas, so that allergic subjects can better enjoy cultural visits and excursions.

The data on pollen concentration in archaeological areas obtained by this method will help to inform people about the presence/absence of allergenic pollen in the air.

Further observations will permit the improvement the proposed method, evaluating the number of treatments and the frequency of monitoring, to achieve better results with minimum effort.

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