Int J Biometeorol (1995) 38:176–179

ORIGINAL ARTICLE

M. Munuera Giner · J. S. Carrión García

Daily variations of *Alternaria* spores in the city of Murcia (semi-arid southeastern Spain)

Relationship with weather variables

Received: 27 September 1994 / Revised: 3 January 1995 / Accepted: 4 January 1995

Abstract Annual variations in the abundance of *Alternaria* spores were related to the length of the spore period for data from Murcia (southeastern Spain). To understand the relationship between the number of spores and climatic factors, *Alternaria* spore counts for March 1993 to February 1994 were examined by means of correlation and regression analyses with fourteen different weather parameters. The results indicated that there was a tendency for *Alternaria* spore concentrations to increase with increases in temperature, wind speed and hours of sunshine. Negative correlations were observed with air pressure, wind direction and humidity. Theoretical curves for *Alternaria* spore counts are given in relation to temperatures during the period studied.

Key words Spores · *Alternaria* · Weather variables · SE Spain

Introduction

Alternaria is a saprophytic fungus distributed throughout the world and, like other fungi, is well known for requiring certain optimum conditions for each phase of its growth. For example associations with humidity and temperature have been well documented in the mycological literature. It has also been established that changes in weather produce fluctuations in the atmospheric spore concentration. However, the contents of the airspora also fluctuate for biological reasons, such as the growth and differentiation of spores (Gregory 1973).

Alternaria together with *Cladosporium* has been considered to be the most prevalent of mould allergens (Budd 1986; Vijay et al. 1991). It has been described as one of the major fungi responsible for inhalation allergies in man (Caretta 1992), thus explaining why *Alternaria* spores are counted in many areobiological stations along with airbone pollen. Climatic information is of great importance in the management and/or prevention of respiratory allergic diseases (Hasnain 1993). An investigation into the effects of these different factors on the incidence of airborne spores is of particular interest, in view of the fact that the relationship between airborne pollen and meteorological conditions is a complex.

Because of its geographical position, Murcia presents a semi-arid rainfall regime (250–300 mm), with a mean relative humidity of 58% and mean annual temperature of 18° C. Within a radius of 15 km around the sampling site, a total of nearly 400000 people live in about 50 towns and villages (including Murcia city). The aim of this paper is to investigate possible relationship from 1 March 1993 to 28 February 1994 between the concentrations of *Alternaria* spores and climatic variables in the area. Statistical models have been evaluated in an attempt to make initial predictions relating *Alternaria* counts in the Murcia atmosphere and climatic parameters.

M. Munuera Giner · J. S. Carrión García (✉)
Laboratorio de Palinología, Departamento de Biología Vegetal, Facultad de Biología, Universidad de Murcia, E-30100 Murcia, Spain

Materials and methods

From 1 March 1993 to 28 February 1994, a Burkard volumetric 7-day recording spore trap (Hirst 1952) was operated at about 19 m above ground level, on the exposed flat roof of the Veterinary Faculty, Espinardo Campus, Murcia University (110 m above sea-level, 38°01′N, 01°10′W, 4 km NW of Murcia city). For recording purposes, slides were prepared following standard methods (Ogden et al. 1974) and examined by light microscopy. The data expressed as number of spores/m^3 of air were obtained by counting all *Alternaria* spores on four longitudinal transects. Those daily slides spoiled by insects were ignored. Meteorological data were obtained from the monthly bulletin of the Centro Meteorológico Territorial of the Instituto Nacional de Meteorología in Murcia, located 1 km from the sampling site. The relationship between *Alternaria* spores and weather variables was explored by the Spearman rank correlation coefficient method. When this index was statistically significant, a numerical approach to *Alternaria* spore distribution was made by discrete (Poisson) regression analysis, giving a theoretical pattern adjusted to a curve and corresponding to:

$y=e^{a+bx+cx^2}$
where y is the expected response of *Alternaria*,
x is the variable explained, and
a, b and c are regression coefficients.

All calculations were made using version 5.0 of the computer program Systat (Systat, Evanston, Wyoming, USA).

Results and discussion

During the period between March 1993 and February 1994, *Alternaria* spores were the most common element found in the Murcia atmosphere, with a total of 10,804 spores, representing 27.7% of total airborne particles identified. *Alternaria* appeared every day of the year (Fig. 1), the mean daily average being 31 spores/m^3 although two principal periods of occurrence were observed: a short season in June and a longer one during autumm (Fig. 1). From the total of 343 days considered, 140 produced spore counts exceeding 31 spores/m^3, 68 days presented counts of more than 50 spores/m^3 and 8 days presented more than 1% of the total annual count.

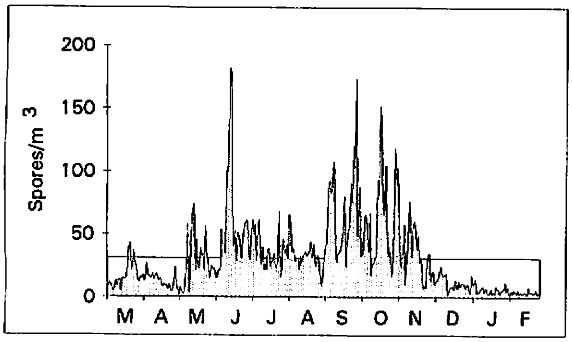
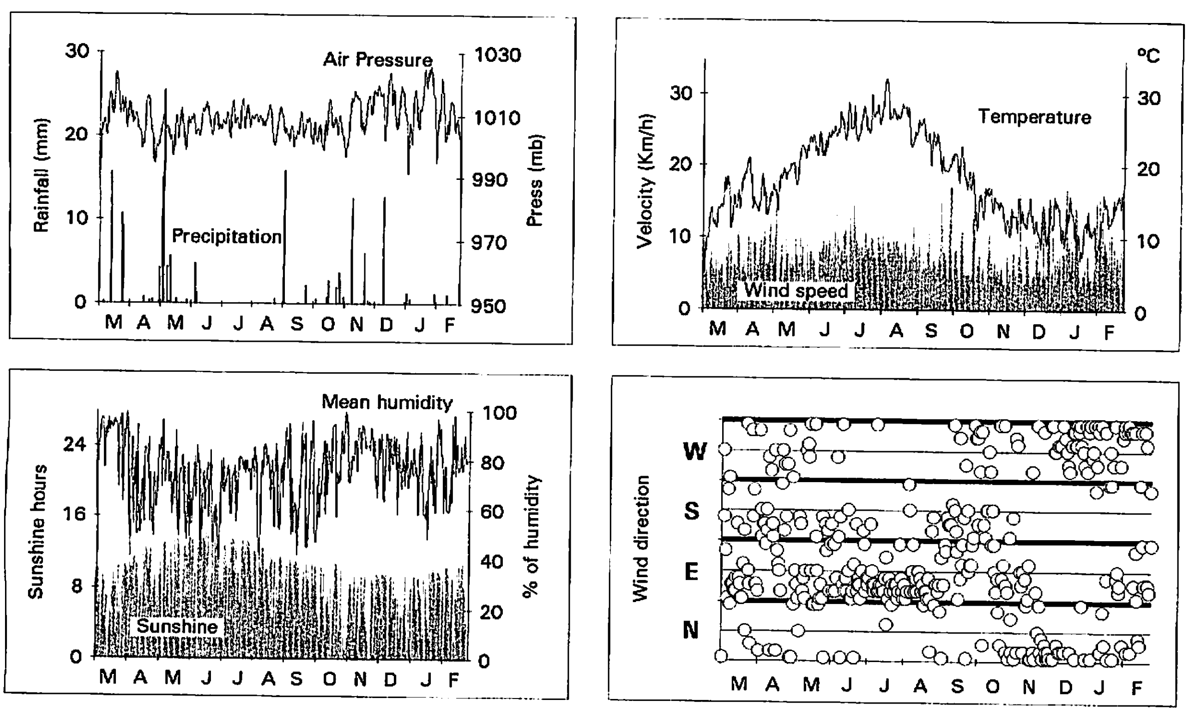


Fig. 1 Daily variations of *Alternaria* spores. The *horizontal line* indicates a mean daily average of 31 spores/m^3

Fig. 2 Daily meteorological data of rainfall, wind speed, wind direction, and sunshine hours



Meteorological data used in the analyses included air pressure, rainfall, temperature, mean wind speed and direction, humidity and sunshine. Daily variations of the meteorological data are represented in Fig. 2. After mathematical analyses, significant correlations were obtained between *Alternaria* spore counts and temperature, maximum and mean air pressure, wind direction and total hours of sunshine (Table 1). The results indicate a possible dependence of the concentration of *Alternaria* spores in the atmosphere on the foregoing climatic factors. From the theoretical patterns obtained by discrete (Poisson) regression analysis of these factors, only those concerning temperatures could be regarded as acceptable (Fig. 3).

Temperature, sunshine and humidity are meteorological factors which are mutually dependent. Thus, a positive correlation between *Alternaria* airspore counts and sunshine could explain, at least partly, the positive correlations of *Alternaria* with temperatures and negative ones with humidity, as obtained in Murcia during the period studied (Table 1). Despite the nonsignificant negative relationship of humidity with the *Alternaria* airspore count and the positive one with total sunshine it would seem that temperature is the most important factor affecting *Alternaria* airspora concentrations in Murcia.

Although the statistical analysis of 1 year's data is obviously insufficient to establish a model for *Alternaria* spore concentrations in relation to climate, we observed between March 1993 and February 1994 that optimum growth temperatures (more than 45 spores/m^3) occurred

Table 1 Spearman's correlation coefficients (r_s) for meteorological parameters (independent variables) and total *Alternaria* counts (dependent variable)

Temperature			Humidity			
Maximum	Minimum	Mean	07.00 h	13.00 h	18.00 h	Mean
0.5507***	0.6189***	0.6095***	–0.1231	–0.0514	–0.0993	–0.1017
Air pressure			Wind		Sunshine	Rainfall
Maximum	Minimum	Mean	Direction	Velocity	Duration	Amount
–0.2990**	–0.1803	–0.2351**	–0.2725**	0.0436	0.1950*	–0.0453[a]

Significance level:
* 5% (0.195),
** 1% (0.254),
*** 0.1% (0.321)
[a] Only for rainy days

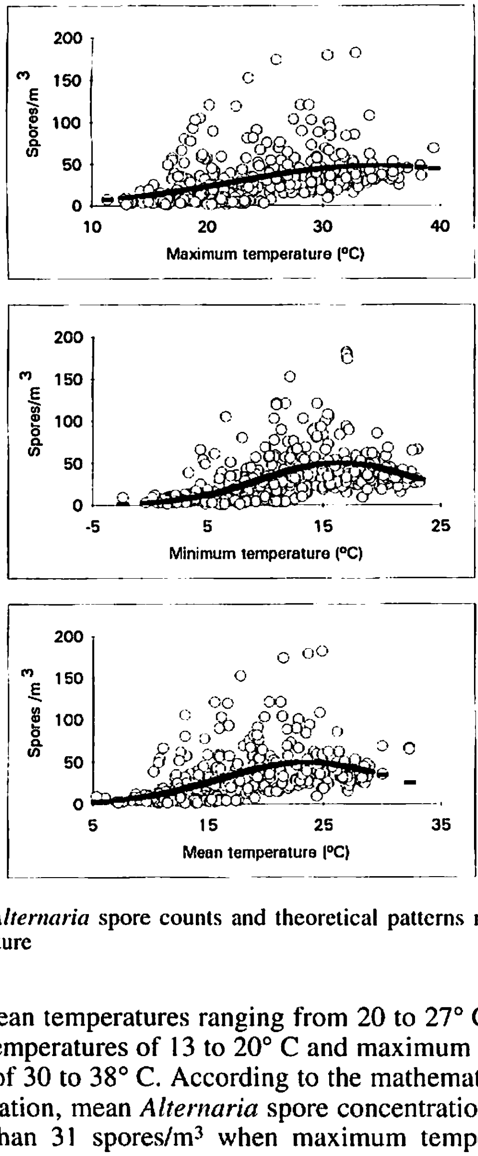


Fig. 3 *Alternaria* spore counts and theoretical patterns related to temperature

over mean temperatures ranging from 20 to 27° C, minimum temperatures of 13 to 20° C and maximum temperatures of 30 to 38° C. According to the mathematical approximation, mean *Alternaria* spore concentrations were more than 31 spores/m^3 when maximum temperatures were higher than 25° C, minimum temperatures were higher than 9° C and/or mean temperatures were higher than 16° C. However, the spore concentration began to fall when maximum temperatures were higher than 34° C, minimum temperatures were higher than 16° C and/or mean temperatures were higher than 24° C. The optimum range of growth temperature (mean temperature 20–27° C) was similar to but about 2° C lower, than was reported by Hjelmroos (1993) in Stockholm, Sweden.

At the moment no firm statistical models and no more accurate approaches can be made regarding the influence on *Alternaria* spores of individual or combined climatic factors in the Murcia area. Further studies on several years' data will perhaps be of help in this task.

We cannot extrapolate results between sites because locals factors seem to have a great influence on airspora behaviour. In relation to *Alternaria*, a number of studies have been carried out throughout the world relating the effects of climatic factors on aerial diffusion of spores. For the best part, temperature and relative humidity have seemed to be the most important meteorological factors involved in the release and dispersal of airspora (Lyon et al. 1984, Kansas, USA; Rosas et al. 1990, Mexico city, Mexico; Srivastava and Wadhwani 1992, Lucknow, India), but the results are diverse and some of them also show correlations with other factors: Hawke and Meadows 1989 (Capetown, South Africa; wind speed and sunshine hours); Palmas and Cosentino 1990 (Cagliari and Sanlury, Sardinia, Italy; temperature, humidity and rainfall); Cadman 1991 (Pretoria and Johannesburg, South Africa; wind speed, pressure and rain); Hasnain 1993 (Auckland, New Zealand; wind speed); Hjelmroos 1993 (Stockholm, Sweden; temperature, wind speed and humidity); Fernández-González et al. 1993 (León, España; temperature, rain and humidity).

Acknowledgements The authors thank the Comunidad Autónoma de Murcia (PIB93/08) and Ministerio de Educación y Ciencia (D.G.I.C.Y.T. PB91-0897) for financial support and the Centro Meteorológico Regional de Murcia for providing meteorological data.

References

Budd TW (1986) Allergens of *Alternaria*. Grana 25:147–174

Cadman A (1991) Airspora of Johannesburg and Pretoria, South Africa, 1987/88. II. Meteorological relationships. Grana 30: 181–183

Caretta G (1992) Epidemiology of allergenic disease the fungi. Aerobiologia 8:439–445

Fernández-González D, Suárez-Cervera M, Díaz-González T, Valencia-Barrera RM (1993) Airborne pollen and spores of León (Spain). Int J Biometeorol 37:89–95

Gregory PH (1973) Microbiology of the atmosphere, 2nd edn. Leonard Hill, London

Hasnain SM (1993) Influence of meteorological factors on the air spora. Grana 32:182–187

Hawke PR, Meadows ME (1989) Winter airspora and meteorological conditions in Cape Town, South Africa. Grana 28: 187–192

Hirst JM (1952) An automatic spore trap. Ann Appl Biol 39:257–265

Hjelmroos M (1993) Relationship between airborne fungal spore presence and weather variables. *Cladosporium* and *Alternaria*. Grana 32:40–47

Lyon FL, Kramer CL, Eversmeyer MG (1984) Variation of airspora in the atmosphere due to weather conditions. Grana 23:177–181

Ogden EC, Raynor GS, Hayes JV, Lewis DM, Haines JH (1974) Manual for sampling airborne pollen. Hafner Press, New York

Palmas F, Cosentino S (1990) Comparison between fungal airspore concentration at two different sites in the South of Sardinia. Grana 29:87–95

Rosas I, Escamilla B, Calderón C, Mosiño P (1990) The daily variations of airborne fungal spores in Mexico City. Aerobiologia 6:153–158

Srivastava AK & Wadhwani K (1992) Dispersion and allergenic manifestations of *Alternaria* airspora. Grana 31:61–66

Vijay HM, Burton M, Young NM, Copeland DF, Corlett M (1991) Allergenic components of isolates of *Cladosporium herbarum*. Grana 30:161–165