

Occupational asthma in greenhouse workers

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Purpose of review

A prevalence of asthma over 5% has been reported in flower farmers, and work inside greenhouses has emerged as an additional risk factor. Workplace determinants behind this high prevalence has been examined, and a prevalence of sensitization to workplace allergens over 30% has been reported being pollens, moulds, and *Tetranychus urticae* allergens the main sensitizers. Bronchial challenge tests in the workplace have demonstrated occupational asthma in more than 20% of the sensitized greenhouse growers.

Recent findings

Air contamination inside greenhouses is mainly related to moulds, and is facilitated by the high indoor temperature and humidity. *Cladosporium*, *Penicillium*, *Aspergillus*, and *Alternaria* and a wide range of flower pollens are able to sensitize the greenhouse worker and cause occupational asthma. *Tetranychus urticae* have allergens shared with other mites, but the low prevalence of cross-sensitization between them confirm that *Tetranychus urticae* contains species-specific allergens that may cause respiratory symptoms. Additionally, working inside greenhouses has been related to an increase in the prevalence of chronic bronchitis in nonsmokers.

Summary

The cultivation of greenhouse crops may cause occupational asthma through sensitization to workplace pollens, moulds, and *Tetranychus urticae* allergens. In greenhouse flower growers, skin testing identifies sensitization to these allergens in one third of the growers, and more than one fifth of the sensitized workers will develop occupational asthma. Greenhouse work has also been related to chronic bronchitis in nonsmokers, suggesting a causal effect of greenhouse air contaminants on this disease as well.

Keywords

greenhouse, asthma, sensitization, flowers, moulds, *Tetranychus urticae*, chronic bronchitis

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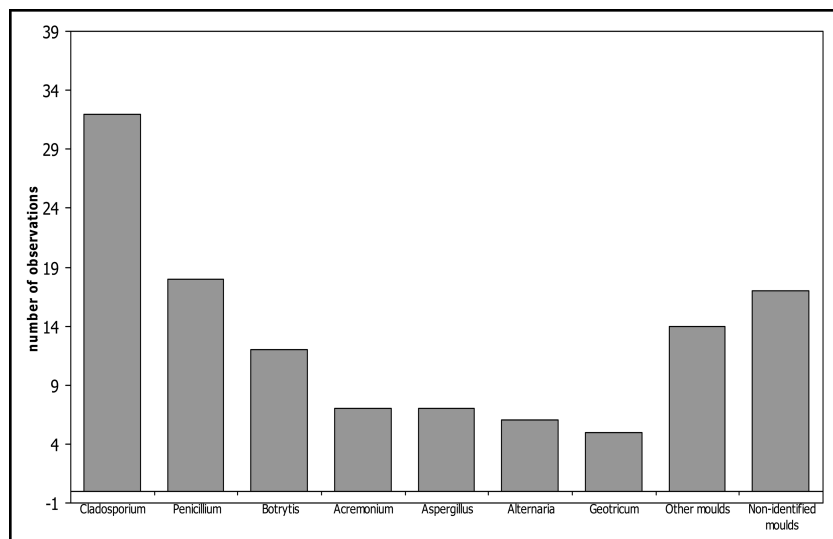
Introduction

Agriculture workers are currently exposed to a variety of respiratory irritants and sensitizers, such as pollens, moulds, endotoxin, mites, and pesticides [1–3], and the exposure to field crops for long periods has been considered a risk factor for respiratory symptoms [4]. The European Farmers' Study reported a 3.2% asthma prevalence for crop farmers [5], a figure similar to that reported for the general European population [6], but demonstrated an increase in the prevalence of respiratory symptoms in farmers cultivating some specific crops, like grain, oil plants, and flowers [5]. An unexpectedly high 5.1% prevalence of asthma for flower and/or ornamental plant growers emerged from that study, and working with this crop turned out to be a statistically significant risk factor for this disease (adjusted OR 2.1, 95% CI: 1.1–3.9). Additionally, the European Farmers' Study pointed to an increase in the prevalence of asthma in growers working inside greenhouses, up to 10% when the growers spend more than two hours per day working inside, and this relation approached statistical significance (adjusted OR 2.1, 95% CI: 0.9–4.5). Greenhouse cultivation was used by almost 30% of the flower growers participating in the European Farmers' Study, and was also used by 15% of the farmers cultivating vegetables and/or tomatoes and almost 10% of the fruit growers [5,7].

Indoor air contaminants

Air contaminants inside flower greenhouses has been measured and compared with air contaminants in animal confinement houses, an occupational environment that causes respiratory symptoms at work [8••]. Flower greenhouses usually have a bigger size than confinement buildings, usually over 1000 square meters, and have a minimal air contamination by dust, unmeasurable in most cases, and endotoxin, that exceptionally reaches concentrations over 10 ng/cubic meters. The temperature inside greenhouses, however, is usually higher than the temperature in confinement buildings, and this characteristic, together with the high indoor humidity, allows for the growing of moulds, which may reach concentrations of over 10,000 colony-forming units per cubic meter [8••]. In this environment, common respiratory sensitizers like *Cladosporium*, *Penicillium*, *Aspergillus*, and *Alternaria*, can be easily recovered [9] (Fig. 1).

Pesticides are often used inside greenhouses, and in the European Farmers' Study, three quarters of the studied

Figure 1. Air contamination by moulds inside greenhouses (n = 39)

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greenhouse farmers sprayed pesticides inside the greenhouse at least once per week [8••]. These products attain measurable concentrations inside the greenhouse [10], and can cause systemic disease [3]. Types of pesticide used and application patterns according to season make it difficult to correlate exposure to respiratory symptoms in greenhouse growers. However, the use of pesticides was found to be a well-defined risk factor for asthma in a cross-sectional study that examined open-air crop farmers [12].

Sensitization

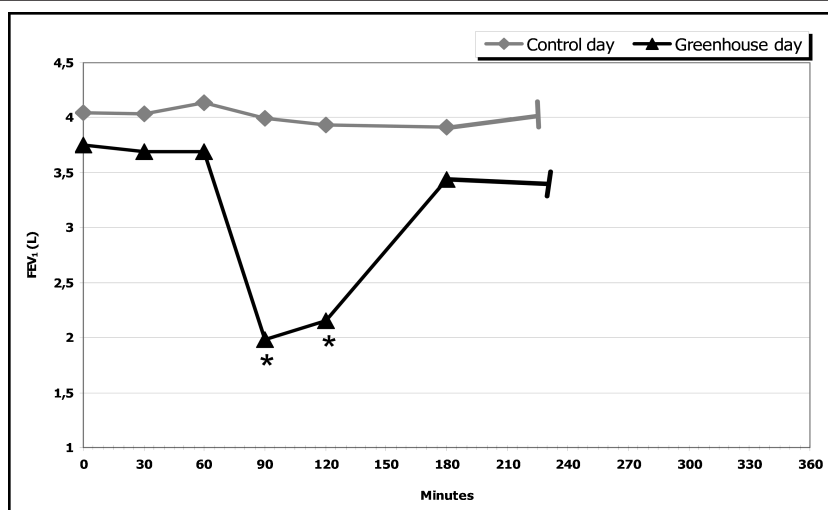
Sensitization to *Cladosporium*, *Penicillium*, *Aspergillus*, and/or *Alternaria* has been reported in near 20% of the greenhouse flower growers [9], but greenhouse workers are also exposed to other allergenic agents such as flower pollens and the *Tetranychus urticae* allergens that can cause sensitization and asthma. Goldberg *et al.* [13], in a cross-sectional study of 75 flower growers, found sensitization to flower allergens in one half of the subjects, a prevalence much higher than found in a reference population. Similarly, Monso *et al.* [9] found a prevalence of sensitization over 20% in greenhouse flower growers, unrelated to the greenhouse characteristics or the concentration of indoor sensitizers, but closely associated with atopy [9]. The range of flowers with antigenic capabilities in these two studies was very wide, and includes members of the *Asteraceae*, *Ranunculaceae*, *Liliaceae*, *Scrophulariaceae*, and *Genetiaceae* families. These observations agreed with the occasional published reports of individual cases of sensitization and asthma symptoms in flower handlers [14–20].

Tetranychus urticae, a mite that may infest a wide range of plants and can be found in greenhouses growing vegetables, tomatoes, or flowers [21–23], has been related to

sensitization and the appearance of work-related symptoms [21–25]. Astarita *et al.* [26] studied 46 symptomatic growers, some of whom worked inside greenhouses, and found that three quarters of them were sensitized to this mite. Various relevant allergens have been described in *Tetranychus urticae*, with molecular masses between 14 and 75 kDa [27,28••]. Some of these antigens are shared with other mites, like the citrus red mite and house-dust mites, but cross-sensitization between them are found in less than one third of the subjects, suggesting that *Tetranychus urticae* contains species-specific allergens in addition to shared allergens [28••,29].

Occupational asthma

In the European Farmers' Study a high prevalence of sensitization to workplace flowers and/or molds was found, and almost one quarter of the sensitized workers suffered from occupational asthma. A workplace bronchial challenge showed significant bronchial reactivity to diagnose occupational asthma in 3 of 13 (23%) sensitized workers [9](Fig. 2). In this study, both flower allergens and molds were the main allergens related to disease, and *Tetranychus urticae* sensitization had only a minimal impact on the reported symptomatology. Sensitization to *Tetranychus urticae* was found only in 2 of 39 growers (5%), one of them reporting respiratory symptoms, but with a workplace bronchial challenge test not confirming occupational asthma (unpublished observations). The impact of workplace sensitization to flower allergens was also assessed by Goldberg *et al.* [13], who reported that 15% of their flower growers abandoned the occupation because of unbearable symptoms, suggesting that their sensitization was clinically significant. Occasional single cases of occupational asthma due to greenhouse moulds have been also reported, confirming the impact of greenhouse sensitization by these allergens on the workers' daily life

Figure 2. Positive bronchial provocation challenge at the workplace in a greenhouse flower grower

*FEV1 decrease $\geq$ 20% of baseline. Published with permission [9].

[30], and similar observations have been reported in greenhouse tomato [22] and flower [21] growers sensitized to *Tetranychus urticae* allergens.

Toxic pneumonitis and chronic bronchitis

The low level of dust and endotoxin found inside greenhouses do not suggest that these substances are clinically significant as triggers of the symptoms reported by the greenhouse growers [8••]. Although exposure to endotoxin in grain handlers has been associated with respiratory symptoms [31], this effect is related to inhaled dose and does not appear when the workers are exposed only to low concentrations [32]. In spite of the low level of dust and endotoxin, poor ventilation emerged as a marginally significant risk factor for wheezing in the European Farmers' Study [9], suggesting that exposure to unidentified air contaminants may reach irritant concentrations in less ventilated greenhouses. Supporting this hypothesis, in a recent study that included almost 9000 European and North American farmers, flower growing, the main greenhouse crop, was not only associated with asthma (adjusted OR 1.71, 95% CI: 1.06–2.77), but also to toxic pneumonitis (adjusted OR 1.75, 95% CI: 1.29–2.38) and chronic bronchitis (adjusted OR 1.67, 95% CI: 1.22–2.27). In this study, working inside greenhouses emerged to a significant risk factor for chronic bronchitis in nonsmokers (adjusted OR 1.59, 95% CI: 1.02–2.48), who reported a 15% prevalence of this respiratory symptom if working inside, much higher than the 9% prevalence reported in nonsmoking outdoor farmers [33••]. These observations suggest that daily work inside greenhouses may cause chronic bronchitis through the inhalation of undetermined irritants.

Conclusion

In summary, the cultivation of greenhouse crops may cause occupational asthma through sensitization to workplace pollen, moulds, and *Tetranychus urticae* allergens. In

greenhouse flower growers skin testing identifies sensitization to these allergens in one third of the growers, and in one quarter of the sensitized workers asthma symptoms develop with an identifiable pattern of occupational asthma. Furthermore, work inside greenhouses is also related to an increase in the prevalence of chronic bronchitis in nonsmokers, suggesting a wider causal effect of this occupational exposure on respiratory disease.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- Of special interest
 - Of outstanding interest
- 1 Bessot JC, Blaumeiser M, Kopferschmitt MC, Pauli G: Occupational asthma in an agricultural setting. *Rev Mal Respir* 1996, 13:205–215.
 - 2 Senthilselvan A, McDuffie HH, Dosman JA: Association of asthma with use of pesticides. Results of a cross-sectional survey of farmers. *Am Rev Respir Dis* 1992, 146:884–887.
 - 3 Alvarez E, Aurrekoetxea JJ, Santa Marina L, Marzana I: Exposure to organophosphorous plaguicides in greenhouse workers in the Basque Country (Spain). *Med Clin (Barc)* 1993, 101:681–683.
 - 4 Gramsky TE, Schenker MB, McCurdy SA, Samuels SJ: Smoking, respiratory symptoms, and pulmonary function among a population of Hispanic farmworkers. *Chest* 1992, 101:1361–1368.
 - 5 Monsó E, Magarolas R, Radon K, et al.: Respiratory symptoms of obstructive lung disease in European crop farmers. *Am J Respir Crit Care Med* 2000, 162:1246–1250.
 - 6 Jee YK, Park HS, Kim HY, et al.: Two-spotted spider mite (*Tetranychus urticae*): an important allergen in asthmatic non-farmers symptomatic in summer and fall months. *Ann Allergy Asthma Immunol* 2000, 84:543–548.
 - 7 Radon K, Monso E, Weber C, et al.: Prevalence and risk factors for airway diseases in farmers. Summary of results of the European Farmers' Project. *Ann Agric Environ Med* 2002, 9:207–213.
 - 8 Radon K, Danuser B, Iversen M, et al.: Air contaminants in different European farming environments. *Ann Agric Environ Med* 2002, 9:41–48.
 - The authors measured the levels of air contaminants inside greenhouses, and found a low concentration of dust and endotoxin, but a high concentration of moulds.
 - 9 Monsó E, Magarolas R, Badorrey I, et al.: Occupational asthma in greenhouse flower and ornamental plant growers. *Am J Respir Crit Care Med* 2002, 165:954–960.
 - 10 Guardino X, Obiols J, Rosell MG, et al.: Determination of chlorpyrifos in air, leaves and soil from a greenhouse by gas-chromatography with nitrogen-

- phosphorus detection, high performance liquid chromatography and capillary electrophoresis. *J Chromatogr A* 1998, 823:91–96.
- 11 Deleted in proofs.
 - 12 Senthilselvan A, McDuffie HH, Dosman JA: Association of asthma with use of pesticides. Results of a cross-sectional survey of farmers. *Am Rev Respir Dis* 1992, 146:884–887.
 - 13 Goldberg A, Confino-Cohen R, Waisel Y: Allergic responses to pollen of ornamental plants: High incidence in the general atopic population and specially among flower growers. *J Allergy Clin Immunol* 1998, 102:210–214.
 - 14 Piirila P, Keskinen H, Leino T, et al.: Occupational asthma caused by decorative flowers: review and case reports. *Int Arch Occup Environ Health* 1994, 66:131–136.
 - 15 Giavina-Bianchi PF Jr, Castro FF, Machado ML, Duarte AJ: Occupational respiratory allergic disease induced by *Passiflora alata* and *Rhamnus purshiana*. *Ann Allergy Asthma Immunol* 1997, 79:449–454.
 - 16 Kanerva L, Makinen-Kiljunen S, Kiistala R, Granlund H: Occupational allergy caused by spathe flower (*Spathiphyllum wallisii*). *Allergy* 1995, 50:174–178.
 - 17 Piirila P, Kanerva L, Alanko K, et al.: Occupational IgE-mediated asthma, rhinoconjunctivitis, and contact urticaria caused by Easter lily (*Lilium longiflorum*) and tulip. *Allergy* 1999, 54:273–277.
 - 18 Vidal C, Polo F: Occupational allergy caused by *Dianthus caryophyllus*, *Gypsophila paniculata*, and *Lilium longiflorum*. *Allergy* 1998, 53:995–998.
 - 19 deJong NW, Vermeulen AM, Gerth vanMijk R, deGroot H: Occupational allergy caused by flowers. *Allergy* 1998, 53:204–209.
 - 20 Miesen WM, Van der Heide S, Kerstjens HA, Dubois AE, et al.: Occupational asthma due to IgE mediated allergy to the flower *Molucella laevis* (Bells of Ireland). *Occup Environ Med* 2003, 60:701–703.
 - 21 Delgado J, Orta JC, Navarro AM, et al.: Occupational allergy in greenhouse workers: sensitization to *Tetranychus urticae*. *Clin Exp Allergy* 1997, 27: 640–645.
 - 22 Erlam AR, Johnson AJ, Wiley KN: Occupational asthma in greenhouse tomato growing. *Occup Med (Lond)* 1996, 46:163–164.
 - 23 Orta JC, Navarro AM, Bartolomé B, et al.: Comparative allergenic study of *Tetranychus urticae* from different sources. *J Invest Allergol Clin Immunol* 1998, 8:149–154.
 - 24 Delgado J, Gomez E, Palma JL, et al.: Occupational rhinoconjunctivitis and asthma caused by *Tetranychus urticae* (red spider mite). A case report. *Clin Exp Allergy* 1994, 24:477–480.
 - 25 Jee YK, Park HS, Kim HY, et al.: Two-spotted spider mite (*Tetranychus urticae*): an important allergen in asthmatic non-farmers symptomatic in summer and fall months. *Ann Allergy Asthma Immunol* 2000, 84:543–548.
 - 26 Astarita C, Franzese A, Scala G, et al.: Farm workers' occupational allergy to *Tetranychus urticae*: clinical and immunologic aspects. *Allergy* 1994, 49:466–471.
 - 27 Orta JC, Navarro AM, Bartolome B, et al.: Comparative allergenic study of *Tetranychus urticae* from different sources. *J Investig Allergol Clin Immunol* 1998, 8:149–154.
 - 28 Park HS, Jee YK, Kim YK, et al.: Identification of immunoglobulin E binding components of the two-spotted spider mite *Tetranychus urticae*: allergenic relationships with the citrus red mite and house-dust mite. *Allergy Asthma Proc* 2002, 23:199–204.
 - The authors assess cross-sensitization to red spider mite, citrus red mite, and house-dust mites and identify common allergens and red spider mite specific allergens.
 - 29 Jee YK, Park HS, Kim HY, et al.: Two-spotted spider mite (*Tetranychus urticae*): an important allergen in asthmatic non-farmers symptomatic in summer and fall months. *Ann Allergy Asthma Immunol* 2000, 84:543–548.
 - 30 Farruggia E, Bellia M: Occupational allergic asthma in greenhouses. Report of a clinical case. *Med Lav* 2001, 92:203–205.
 - 31 Schwartz DA, Thorne PS, Yagla SJ, et al.: The role of endotoxin in grain dust-induced lung disease. *Am J Respir Crit Care Med* 1995, 152:603–608.
 - 32 Post W, Heederik D, Houba R: Decline in lung function related to exposure and selection processes among workers in the grain processing and animal feed industry. *Occup Environ Med* 1998, 55:349–355.
 - 33 Monsó E, Schenker M, Radon K, et al.: Region-related risk factors for respiratory symptoms in European and Californian farmers. *Eur Respir Dis* 2003, 21:323–331.
 - The authors assess the prevalence and risk factors for respiratory symptoms in a population sample of 9000 farmers. The size of the sample allows the identification of the effect of greenhouse work on nonsmokers, with an increase in the prevalence on chronic bronchitis.