

The importance of the pecan tree pollen in allergic manifestations

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Summary

Background Pecan tree pollen is considered to be highly allergenic. However, no specific scientific data about its role in causing allergic diseases are available.

Objective To study the role of pecan tree pollen in the development of allergy.

Methods The presence of pecan tree pollen was determined by weekly and monthly counting of airborne grains. The incidence of pecan tree pollen atopy and clinical manifestations were studied in 395 participants, aged 4–70 years, who comprised 78.2% of the whole eligible population of a rural community. The participants were skin tested for different extracts of allergens, completed detailed questionnaires, and their medical files were evaluated.

Results During May, pecan tree pollen grains comprised 70% of the total airborne grains. A positive skin-prick test (SPT) to pecan was shown by 46 (11.6%) participants, constituting 25.4% of the atopic population. Of those who were found atopic to one or more allergens 50.3% had symptoms, whereas the parallel figure for those atopic to pecan pollen was 76.1% ($P < 0.005$); 58.7% of the pecan atopic participants had hay fever, 43.5% had asthma, and 31.5% had both hay fever and asthma. Among pecan atopic participants the incidence of hay fever increased with age ($P = 0.05$), while the incidence of bronchial asthma, as a sole manifestation of allergy, decreased in the > 17-year-old age group ($P < 0.01$). Of the pecan atopics 65.2% had clinical symptoms coinciding only with the pecan pollen season and an additional 10.9% had perennial symptoms.

Conclusion Pecan tree releases highly allergenic pollen grains, which are correlated to the incidence of hay fever in the exposed population. The contribution of pecan tree pollen to the symptoms was highly significant after discounting olive and cypress trees that also pollinate in the spring. In children, the pecan tree constitutes a possible etiologic agent for the development of asthma.

Keywords: asthma, atopy, cypress, hay fever, olive, pecan, pollen

Clinical and Experimental Allergy, Vol. 26, pp. 323–329. Submitted 13 June 1995; revised 4 September 1995; accepted 29 September 1995.

Introduction

Allergens in general and aeroallergens in particular are important contributors to allergic diseases. The major

aeroallergens differ according to the geographical area and with the flowering season of the plants [1–3]. It is imperative to recognize the major allergenic contributor specific for each area in order to identify the atopic patients and to prescribe appropriate treatment.

The pecan tree, (*Carya illinoensis*), is widely spread as a crop and shade tree in Israel. The plant has a short

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flowering season, during which it releases large quantities of pollen. Therefore, it constitutes a potential allergenic plant. Pecan is mentioned as an allergenic plant in several textbooks, and in North America is regarded as an important cause of allergic rhinitis [1,2,4]. A definite relationship between the abundance of pecan trees in several regions of Israel and the incidence of skin responders was reported [5]. Nevertheless, we found no specific scientific data regarding the clinical relevance of pecan pollen allergy.

The purpose of our study was to evaluate the contribution of pecan pollen to the development of allergic manifestations in a heavily exposed population of a small rural community. Our data suggested that the pecan tree is likely to be an important cause of atopy and allergic symptoms during the months of April and May.

Methods

Study population

The whole population, aged 4–70 years, irrespective of their clinical status, of a small rural community Netzer Tzireni (NTZ) in Israel, was asked to participate in the study. There were 505 eligible residents, ethnically heterogenic and without familial inter-relationship. The compliance rate was 78.2%, a total of 395 participants. The village is located 12 km from the coast, at sea level, in a temperate climate, typical to the Mediterranean part of Israel (average temperature of $\sim 20^{\circ}\text{C}$, with mean annual rainfall of 500 mm). In this area the pecan tree is very common as a shade tree, at a density of 40 pecan trees per 1 km^2 .

The study was approved by the Ethics Committee of Tel-Aviv University and each participant signed a consent form before completing the questionnaire.

Air sampling

During 3 consecutive years, weekly air sampling, calculated as daily counts, over a week, in an area located $\sim 15\text{ km}$ away from NTZ, demonstrated the pecan tree to be a significant pollinating factor during the end of April through May only [5]. Pecan trees flower once a year and the pollination season is rather consistent [5]. We carried out monthly air sampling during 1992/3 in NTZ. Pollen was sampled using Rotorod samplers, (Sampling Technologies Inc. Los Altos Hills, CA, USA), which sampled the air by impaction [4]. The Rotorod samplers were positioned at a height of 90 cm above the ground, in the open spaces near the dining hall of NTZ. This was the place where most of the residents were exposed several times during the day. The number

of pollen grains per cubic metre was calculated by dividing the number of particles counted by the air volume sampled.

Clinical data collection and analysis

Clinical data were collected from a questionnaire and from the participants' medical files. The questionnaire was completed by each participant or by the parents of children aged 4–17 years. It included details regarding spontaneous and trigger induced wheezing, cough at night that was not associated with respiratory tract infection, rhinitis, sneezing or eye and skin symptoms not associated with infection. Seasonality, duration of symptoms, recurrence and age of the onset of the symptoms, were also recorded. In addition, it inquired whether the participant was ever diagnosed as having asthma or allergic rhinitis by a physician, and if anti-allergic treatment in the past or present had been received. In surveying the medical files we looked for evidence of diagnosis of allergic diseases.

The criteria for asthma and allergic rhinitis were adopted from Broder *et al.* [6] with minor modifications. Patients with a previous diagnosis of allergic conjunctivitis or atopic eczema but no evidence of allergic rhinitis or asthma, were classified as 'others'.

The data given in the questionnaire during the study (1992/93) by the Pecan atopic participants, was verified a year later during April–May 1994, in 42 out of 46 (91%) of the cases.

Skin tests

Skin-prick tests (SPT) were carried out according to published methods [7,8]. The extracts were stored at 4°C . A drop of each extract was placed on the forearm and the skin was pricked through the droplet. SPT were performed on the same arm areas for all allergens, and at the same distances from each other. Excess fluid was blotted off immediately. The diameter of the weal-and-flare were measured after 20 min. A positive response was considered when weal diameter was $\geq 3\text{ mm}$. Histamine (1 mg/mL) was used as a positive control and saline-glycerol solution as a negative control. A participant who had at least one positive SPT was considered atopic. Among the extracts used were pecan (*Carya illinoensis* cv. Wichita type), Olive (*Olea europea*), Date Palm (*Phoenix dactylifera*), Cypress (*Cupressus sempervirens*), Ailanthus, Pigweed (*Amaranthus*), English Plantain (*Plantago*), Sagebrush (*Artemisia*), Lamb's Quarters (*Chenopodium*), two types of grasses, Rye (*Lolium*) and Bermuda (*Cynodon dactylon*), house dust mites (HDM): *Dermatophgoides pteronyssinus* and

Table 1. Study population

Age group	Total population	Number of participants (%)	Number of atopic (%) ⁺
4–10 years	76	59 (77.6)	18 (30.5)
11–17 years	81	73 (90.1)	38 (52.1)
>17 years	348	263 (75.6)	125 (47.5)
All	505	395 (78.2)	181 (45.8)

Population = the target eligible population; participants = number of actual participants; atopic = number of atopic participants (percentage presented in parenthesis).
% — percentage of total population; %⁺ — percentage of participants.

Dermatophgoides farinae, and moulds: *Penicillium* and *Alternaria*. The extracts were supplied from Dome Hollister-Stier and Center. Pecan, Olive and Date palm extracts were obtained from the Department of Botany of Tel-Aviv University. These extracts were standardized on the basis of their protein content and used in concentrations of 3.84, 5, and 2 mg/mL for pecan, olive and date palm, respectively. In preliminary experiments there were no significant differences in the results obtained with the commercial and the other extracts.

Data analysis and statistics

Chi-squared tests with Yates correction and fisher's multiple comparison test were used to assess the significance of difference in prevalence rates.

Results

Study population

The demographic details of the investigated population is shown in Table 1. Nearly 80% of the eligible residents of the community participated in the study, 179 males and 216 females. The highest rate of participation was achieved for the age group of 11–17 years. In other age groups the lower participation rate was explained by either parental refusal to test their young children or due to temporary absence caused by army service, college duties or other personal reasons.

Atopy to pecan and other allergens

Results of the SPT to the various tested allergens are shown in Table 2. Almost half of the participants

Table 2. Results of SPT to selected allergens in the study population

Age group	4–10 years	11–17 years	>17 years	All
Number of participants	59	73	263	395
Number of atopic	18	38	125	181
% of atopic	30.5	52.1	47.5	45.8
Allergens	% of positive SPT (according to age group)			
Pecan	8.5	12.3	12.2	11.6
Cypress	6.8	9.6	12.5	11.1
Palm	**2.3	11	5.7	6.3
Olive	0	8.2	7.2	6.3
Bermuda Grass	*4.2	8.2	12.5	11.1
Rye Grass	3.4	13.7	14.4	12.7
Sagebrush	11.9	16.4	17.5	16.5
Lamb's Quarters	*0.0	5.5	8.7	7.5
Eng. Plantain	0	1.4	4.6	3.3
<i>D. Pteronyssinus</i>	20.3	38.4	25.5	27.1
<i>D. Farinae</i>	16.9	23.3	16	17.5
<i>Alternaria</i>	1.7	1.4	3.4	2.8
<i>Penicillium</i>	0	5.5	2.7	2.8

The results of SPT to each allergen in the various age groups and in the whole study population is shown (all).

* Only 22 participants aged >8 years were examined.

** Only 43 participants aged >6 years were examined.

(45.8%), had positive SPT to one or more of the allergens. Allergy to pecan was found in 46 participants accounting for 11.6% of the total examined population. Pecan was the fourth most common allergen causing atopy, identified in 25.4% of the atopic population. The prevalence of atopy to pecan did not change significantly among the various age groups or with gender (Fig. 1). In contrast, the prevalence of atopy in general was higher in participants aged above 10 years, compared with the younger ones (Fig. 1b) ($P < 0.015$). There was no difference in the prevalence of atopy between males and females, except in the youngest age group (4–10 years) in which atopy among males was higher than in females (Fig. 1b) ($P < 0.025$).

Clinical manifestations

Based on the medical records and on the questionnaires, the participants were assigned as symptomatic or asymptomatic, and further subdivided into more specific clinical diagnoses; rhinitis, bronchial asthma or both (Fig. 2). Symptoms were more prevalent in the atopic population when compared with the non-atopic one and with the whole population, 50.3%, 22.9%, 35.4% respectively,

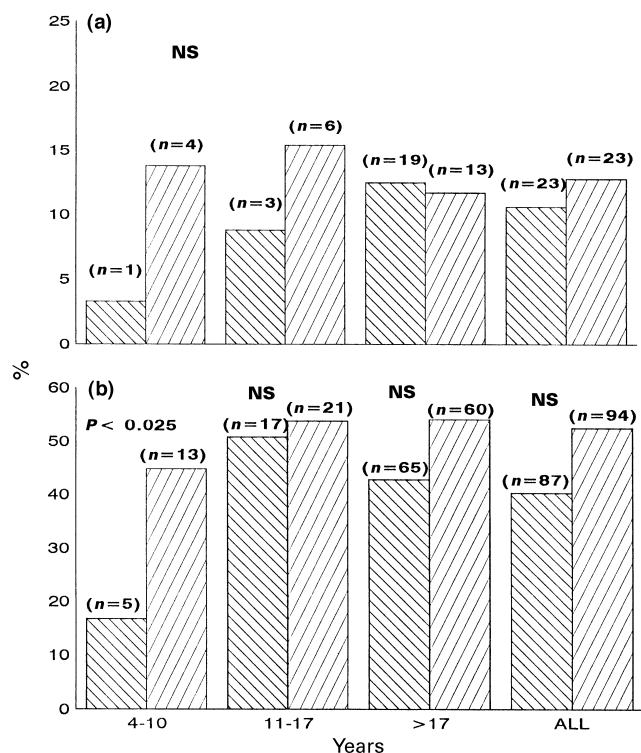


Fig. 1. Prevalence of atopy according to gender and age. (a) Pecan atopic population, 46 participants. (b) General atopic population, 181 participants. The values presented in parenthesis presents the total number of participants in each group, from which the percentage of atopics was calculated. NS. The difference is not statistically significant. ▨. Female. ▩. Male.

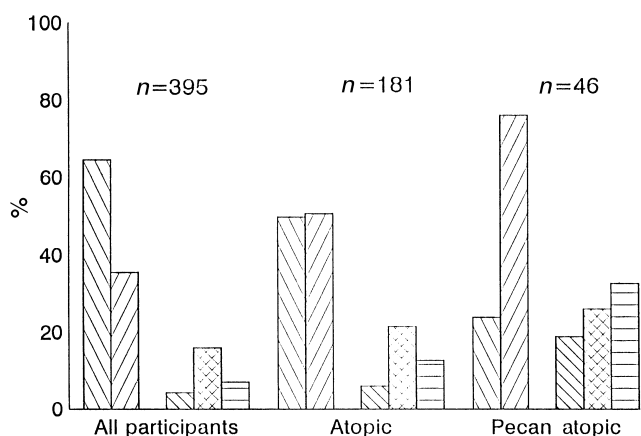


Fig. 2. Comparison of prevalence and type of clinical manifestations between the whole study population, atopic and pecan atopic participants. *n* = number of participants in each presented group. ▨. Asymptomatic. ▩. Symptomatic. ▨. Asthma only. ▩. Rhinitis only. ▨. Asthma & rhinitis.

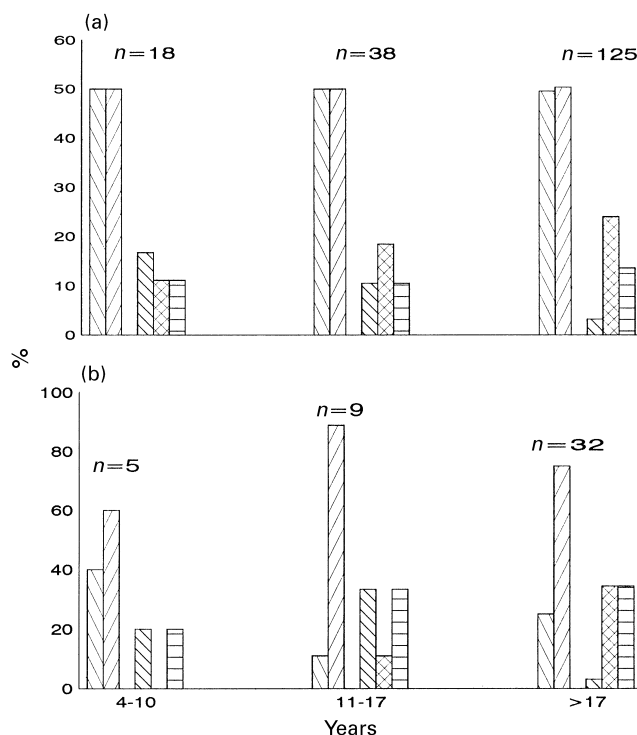


Fig. 3. Comparison of prevalence and type of clinical manifestation between the atopic and pecan atopic participants in various age groups. (a) whole atopic population. (b) Pecan atopic population. ▨. Asymptomatic. ▩. Symptomatic. ▨. Asthma only. ▩. Rhinitis only. ▨. Asthma & rhinitis.

($P < 0.0001$). Among those who were atopic to pecan, 76.1% were symptomatic, ($P < 0.005$). As shown in Fig. 3, rhinitis was the most common diagnosis in the atopics as well as the pecan atopic. However, among pecan atopics, aged 4–17 years, 57% (eight participants) suffered from bronchial asthma, half of them reported of allergic rhinitis as well. Whereas, in the general atopic population, in the similar age group, only 22.4% (13 participants) reported bronchial asthma, 61.5% of them suffered allergic rhinitis as well. The prevalence of bronchial asthma in the pecan atopic population decreased with age ($P < 0.01$), while the prevalence of rhinitis increased ($P = 0.05$). A similar trend was observed also in the general atopic population, but in this group only the decrease in the prevalence of bronchial asthma reached significance ($P < 0.03$).

Seasonal correlation between airborne pollen count and clinical symptoms

In order to estimate the causal relationship between pecan atopy and symptoms, we correlated the flowering

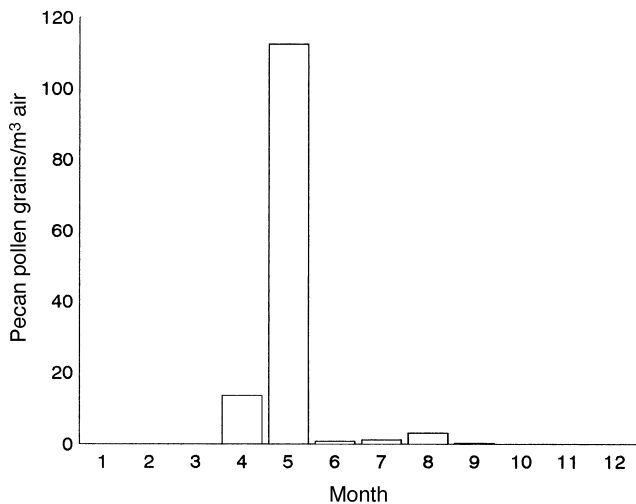


Fig. 4. Annual distribution of airborne pecan pollen. The air was sampled and grains identified and counted as described in the methods. The number of pecan pollen grains per m³ is presented. Air sampling was taken monthly during the last week of each month.

season of pecan trees in the residence area of the patients, with their symptoms. It was confirmed in the research area that pecan trees released their pollen during a well defined season, the second half of April through May, as presented in Fig. 4. During this season, pecan pollen grains constituted 70% of the total airborne pollen. This pollen distribution, was identical to the data obtained by

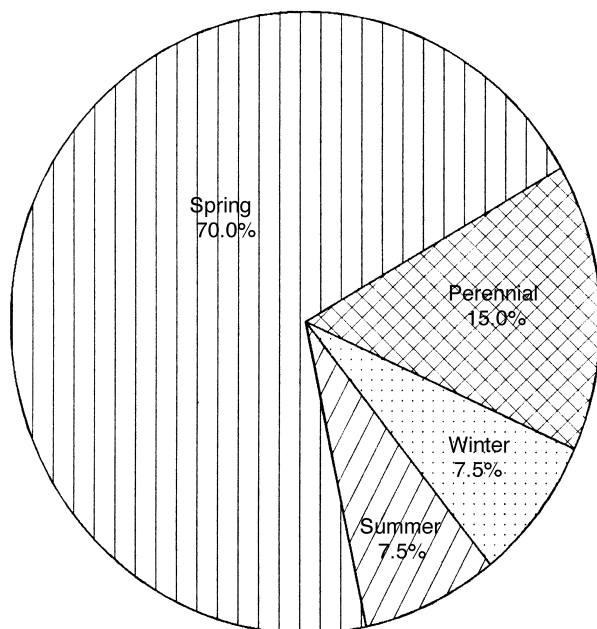


Fig. 5. Symptoms according to season in the pecan atopic population. The season of symptoms in the symptomatic pecan atopic participants ($n = 35$) is presented.

Table 3. Correlation between atopy to pecan, cypress and olive and symptoms

Positive response to SPT			Symptoms		Total
Cypress	Olive	Pecan	Asymptomatic No. (%)	Symptomatic No. (%)	
—	—	—	225 (73.5)	81 (26.5)	306
—	—	+	10 (40)	15 (60)	25
					331
—	+	—	7 (50)	7 (50)	14
—	+	+	0	6 (100)	6
					20
+	—	—	7 (46.7)	8 (53.3)	15
+	—	+	0	9 (100)	9
					24
+	+	—	2 (28.6)	5 (71.4)	7
+	+	+	4 (30.8)	9 (69.2)	13
					20

— represents a negative SPT response + represents a positive SPT response to the indicated allergen. Response to other allergens was not taken into account in this table.

weekly air sampling carried out 15 km away, for clinical purposes, during 1992 through 1994 by the department of botany, Tel-Aviv University (Waisel, Tayar & Keynan — unpublished). The seasonality of symptoms among the pecan atopic symptomatic population is presented in Fig. 5. Eighty-five per cent of the pecan-atopic symptomatic patients exhibited symptoms during the pecan pollination season (Figs 4 and 5), 70% had symptoms during this season only (Fig. 5).

Since during the flowering season of pecan, both the pollen of olive and cypress trees appeared in the sampled air, it was imperative to examine whether or not the pollen of these trees could be responsible for such symptoms. The correlation between atopy to either of these allergens, and the development of symptoms is presented in Table 3. There was a significant correlation between symptoms and atopy to pecan after discounting the contribution of atopy to olive and to cypress ($P < 0.00001$). The parallel figures for cypress and olive were $P < 0.0049$ and $P < 0.897$, respectively. The number of participants who exhibited atopy to pecan pollen only, was only five, and three were symptomatic, suffering from allergic rhinitis during the spring only.

Discussion

This is the first well documented report verifying earlier impressions [1,2,4,5] that pecan pollen has allergenic

clinical significance. Several lines of evidence indicate that pecan pollen is an important allergenic cause in the studied population. First, such pollen was shown to contaminate the air of the examined population. Pecan pollen grains contributed more than 70% of the total grain count in the period April–May. Secondly, pecan pollen was one of the most prevalent sensitizing allergens, even in the young population. Thirdly, the prevalence of symptoms was higher in the pecan atopic population than in the general population. Moreover, the prevalence of symptoms among the pecan atopic population was much higher than in the atopic population in general (Fig. 3). In fact, the prevalence of symptoms in this population was higher among atopics than any other allergen (manuscript in preparation). Fourth, a positive correlation between atopy, clinical manifestations and the season of pollen distribution was shown.

Screening for prominence of allergens, using air sampling [4,5,9–11], SPT [9,12–15] and questionnaires [16–19] is an accepted method. However, in our investigation, we tried to avoid several common pitfalls. In many cases there is a tendency to overestimate the number of symptomatic patients and thus, of allergic individuals [13,20]. In other population studies, the samples included limited age groups but not the whole population [12,15,18,19,21].

Studies where whole populations are evaluated are confined to one aspect of the allergic diseases, i.e. To the symptoms only, or to the aerobiology only, but do not correlate those criteria [6,16,22]. The estimation of prevalence of clinical asthma in several areas of the USA, was based on medical interviews and on physical examinations only [17]. In our study we examined 78.2% of the target population, which included both healthy and sick people in a rural community. This rate of participation was comparable to that obtained by Broder *et al.* [16] (82%) in a large scale study that did not include SPT, and higher than that of Turkeltaub *et al.* [17] who reached only 73.1%. Information on the non-respondents was analysed, and no evidence of a significant bias was observed.

Our study population resides in a 'kibbutz, which is basically a rural community. Based on the questionnaire, inhabitants spend 20–30% of their time outdoors. In the area examined, pecan pollen constitutes 70% of the total pollen grains found in the air in May (grain counts presented in Fig. 4) even though the pecan is only a shade tree in that area. Based upon the weekly counts during 1992–1994, this was the general pattern during May in those years. Although the pollination season of each plant may vary in different climates and geographical distributions, the period in which the pecan pollinates is similar to other geographic areas [1,4].

The indicator for atopy used in the present study was skin-prick test (SPT), which is considered the best method for screening large populations [8,23]. SPT is a highly sensitive test, with good correlation to the bronchial challenge tests, still, the clinical significance should be interpreted in the context of the clinical history.

The issue of extracts used for skin test is a third possible problem. We used a standardized pecan pollen extract derived from the pecan trees prevalent in Israel. In general, there is a good correlation in the results of skin tests between standardized and conventional extracts [24]. Moreover, a specific comparison of these extracts of pecan pollen types showed no significant difference in the prevalence of skin atopy [25]. Of the total participants 45.8% were found to have at least one positive SPT. This value is somewhat higher but in the same range as reported by others, 39% [19] and 29–46% [26]. A detailed discussion of the relation of positive SPT of specific allergenic extracts to the clinical manifestations is beyond the scope of this manuscript.

The pecan tree was found to be one of the major causes of atopy (as were HDM, sagebrush, cypress and grasses, Table 2). Not only that, 11.6% of the total participants exhibit SPT to pecan pollen, but also 76.1% of them were symptomatic. The parallel figure in the general atopic population was 50% ($P < 0.005$). There is major importance to those symptoms in the young (4–17 years), since prevalence of bronchial asthma among pecan atopics is quite significant (Fig. 3).

Moreover, 78.1% of participants atopic to pecan were symptomatic during the specific pollination season (85% of symptomatic). Although pecan tree has a short and well defined pollination season, the data in the questionnaire included details about the season of the symptoms only. Therefore, we confirmed the presence of symptoms during the actual pollination period of the pecan tree a year later, in 91% (42 out of 46) of the participants, through telephone questioning (data not presented). Furthermore, we had to consider other possible inhaled allergenic causes prevalent in the area during the spring, such as the olive and cypress trees [4,27–30]. This was accomplished by a statistical evaluation of the symptoms among the participants atopic to those three allergens (Table 3). The pecan was found to be the most significant tree contributing to symptoms.

In conclusion, this study emphasizes the role of pecan pollen in allergic manifestations. Identification of individuals allergic to pecan tree pollen may be of major importance to avoidance and seasonal preventive treatment, or desensitization treatment. In addition, it is possible that those facts should be included when planning the composition of shade trees.

Acknowledgment

We thank T. Mor R. N. and S. Elinsion R. N. from NZ for helpful cooperation through the study, and Angi Agajany for expert secretarial assistance.

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