

Original article

Epidemiology of allergic occupational diseases induced by *Tetranychus urticae* in greenhouse and open-field farmers living in a temperate climate area

Background: The role of *Tetranychus urticae* (TU) as an occupational allergen has thus far been investigated only in selected farmer samples.

Methods: The prevalence of TU-induced sensitization and occupational diseases in a randomized sample of farmers living in a temperate climate area was investigated. Occupational/nonoccupational symptoms, skin prick test (SPT) results with common allergens and TU, specific occupational test results, and greenhouse or open-field sources of TU exposure were assessed. The study design was cross-sectional.

Results: The prevalence of positive SPT to TU was 6%. TU-induced allergic/nonallergic complaints accounted for 65% of farmers with challenge-confirmed occupational disease. In all farmers, sensitization to common allergens was a risk factor for both current occupational and nonoccupational complaints, while TU sensitization was a prominent risk factor for occupational complaints.

Furthermore, in SPT-positive farmers, only the presence of seasonal occupational complaints was significantly associated with TU sensitization. Common allergen sensitization was a risk factor for development of TU sensitization, which was more frequent in greenhouse than in open-field workers.

Conclusions: TU was a common nontraumatic, allergic occupational hazard for farmers. Since occupational seasonal symptoms could be directly related to the presence of TU sensitization, allergy to this mite should be routinely investigated in farmers.

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Tetranychus urticae (TU) is a macroscopic (0.5–1 mm), phytophagous mite, commonly known as red spider mite, which is ubiquitous in warm regions, infesting many vegetables and ornamental flowers cultured in open fields or greenhouses, as well as other plants and fruit trees in the summer–autumn period (1). We have already described seasonal occupational rhinitis in farm workers, mainly associated with asthma and/or contact urticaria, and an isolated hand-localized recurrent dermatitis, which proved to be allergic occupational complaints provoked by TU (1, 2). These clinical data, along with the role of this mite as a prominent occupational allergen, have also been confirmed in allergic greenhouse workers (3, 4) and in apple-cultivating farmers in a subtropical climate (5). Moreover, TU has been

found to be an important allergen also in asthmatic nonfarmers with symptoms in the summer and autumn (6).

The occurrence of allergic sensitization and related diseases in farmworkers is quite frequent (7, 8), although it is lower in farming environments than in cities and white-collar workers (9, 10). Chronic bronchitis and hypersensitivity pneumonitis have also been frequently reported among farm workers (11, 12). Consequently, a diagnosis of TU-induced allergy might be confused by the potential causative role of other allergens in inducing symptoms in these workers. Moreover, the prevalence of TU-induced, IgE-mediated sensitization or clinical allergy was recently investigated only in apple-cultivating farmers at subtropical climate (5) or in selected greenhouse workers, but not yet in a

general, unselected sample of farmers living in a temperate area. Therefore, the actual importance of this allergen as a cause of occupational complaints in this workforce has yet to be defined.

The aim of this study was to assess, in a temperate climate area and by a large epidemiologic cross-sectional survey, the prevalence of TU-induced sensitization/occupational diseases in farmers, and the value of the clinical history and habitual workplace (greenhouse/open field) for prediction of, or as a risk factor for, TU allergy, respectively. To this end, clinical and occupational data and skin prick test (SPT) results were collected and analyzed. Furthermore, suspected allergic occupational complaints were confirmed by the reappearance of symptoms during specific challenge tests to putative occupational allergens.

Material and methods

A stratified sample of 1280 subjects, randomly selected with computer assistance from about 10 000 active farmers listed in the employment register of a southeastern district of Naples, were invited to complete a detailed, physician-assisted standard questionnaire on persistent/recurrent respiratory and/or cutaneous symptoms, with particular regard to job-related ones.

Out of the 1280 invited subjects, 960 farmers (75% response rate) gave their informed consent and entered the study, which had previously been approved by the ethics committee of the Second University of Naples (Italy).

The family doctors of the enrolled subjects were invited to participate in the investigation. The reasons prompting the study were extensively explained. Farmworkers were invited to see their doctors to have their clinical history taken and the standard questionnaire completed. The criteria used to define clinical diagnoses and the timing of symptoms are shown in Table 1. The questionnaire was elaborated from separate questionnaires on asthma/bronchial hyperresponsiveness and chronic bronchitis, respectively, which had been previously validated in community populations (13–15). The reliability of the composite questionnaire was assessed by a team of 20 medical students on a sample of 210 people aged 18–60 years, randomly selected from the registers of two general practitioners. The results of this pilot were validated in our department against instrumental and specialized clinical examinations, with a resulting minimal sensitivity of 0.38 and minimal specificity of 0.90 for each question.

The clinical status of each subject (occupational/nonoccupational symptoms, no symptoms) was kept blind during subsequent investigations because one of the investigators (C.A.) held relevant information and selected the subjects, as necessary. All subjects, after assessment of their atopic/nonatopic status by SPT reactivity to 24 commercially available (Lofarma Labs, Milan, Italy) local common inhalant and food allergens (CAL) (*Dermatophagoides farinae*, *D. pteronyssinus*, *Tyrophagus putrescentiae*, *Acarus siro*, grass-pollen mixture, wall pellitory, olive and mugwort pollen, outdoor fungi mix, animal epithelia mix, Solanaceae mix, legume mix, Drupaceae mix, wheat, rice, apple, tomato, garlic, onion, celery, meat mix, milk, egg, and cod), underwent a further SPT session using fresh leaves of tobacco and a TU whole-body extract prepared in the laboratory of our department (1).

The results of each SPT session were recorded after 15 min and compared with HCl-histamine (10 mg/ml) as the standard positive reference and normal saline as control. The SPT was considered

positive when it resulted in a wheal with a mean diameter (the mean of the longest and the midpoint orthogonal diameters) at least 3 mm larger than the negative reference (16).

All subjects with at least one positive SPT result to CAL were considered atopic. All the subjects with an isolated skin test positivity to TU (ITU+) came from the previously defined subgroup of “nonatopic” farmworkers, whereas all the subjects with positive skin responses to both TU and common allergens (CALTU+) came from the previously defined subgroup of “atopic” farm workers.

All TU-positive subjects (whether ITU+ or CALTU+), those with occupational complaints (whether atopic or not), and a group of healthy nonatopic farmworkers underwent a single-blind specific TU exposure test in a pesticide-free, oleander greenhouse specifically infested by TU (1). In addition, the patients with occupational complaints were separately subjected to further “open” exposure tests for other putative occupational, natural, fresh, and TU-free sources of allergens such as tomato, celery, and tobacco, to which they had been shown to display positive SPT reactions. The exposure time was 2 h, and patients were asked to behave the same way as during their normal work. Patients were randomly assigned to either one of the authors, who followed up their symptoms and peak expiratory flow rate (PEFR) before, during, and after the exposure period at 30-min intervals for as long as 6 h. Finally, a further clinical assessment was carried out after 24 h to evaluate possible allergic late-phase reactions. A >20% decrease in PEFR and the onset of sneezing attacks and/or aqueous rhinorrhea were considered to be indicative of asthma and rhinitis, respectively (1). Alternatively, the onset on the uncovered skin of hands or arms of erythema and/or wheals or the appearance of erythema and microvesiculated (acute eczematous) eruptions or overlapping urticaria-like and acute microvesiculated lesions was considered to be diagnostic for contact urticaria or to be a worsening of contact dermatitis, respectively (2).

Statistical analysis

The independent sample *t*-test procedure was performed to compare means for continuous variables. For categorical variables, the chi-square test or exact tests were performed as appropriate. Odds ratios were calculated to investigate the association between any current, current occupational, or nonoccupational symptoms (yes/no) and SPT to CAL or TU (positive/negative). Multinomial logistic regression was used to examine the relationship between the type of positive SPT response as categorical dependent variable with three values (CAL [=0]; ITU [=1]; CALTU [=2]) and current symptoms (occupational symptoms, nonoccupational symptoms, or no symptoms) as a categorical independent variable, with no symptoms as the reference category. The coefficients obtained from the logistic regression analyses were also expressed in terms of odds of occurrence of an event.

In patients with job-related complaints, the bivariate correlation between each single organ clinical involvement and TU sensitization was calculated by computing Spearman's coefficient with significance levels. Data are presented as means $\pm$ standard deviations (SD). A *P* value of 0.05 or less was considered significant. The SPSS software package for Windows (release 10.0.7–1 June 2000; SPSS, Inc., Chicago, IL, USA) was used for statistical analysis and selection of random samples.

Results

Data from questionnaire returns and results from SPT

Analysis of questionnaires showed that in this general population sample (508 male and 452 female, aged 34.5 ± 3.7 years, range 19–46 years), 170 (17.7%) and 150 (15.6%) subjects had had either lifelong or current respiratory and/or cutaneous symptoms, respectively (Table 1).

Table 1. Criteria used to define clinical diagnosis and timing of complaints in farmworker population

•Rhinitis
(Yes response to at least one of following clinical profiles)
Seasonal sneezing attacks, aqueous rhinorrhea with variable nasal blockage or itching
Nasal blockage, intermittent mixed aqueous/mucous rhinorrhea with variable sneezing attacks
Serious perennial nasal blockage
•Asthma
(Yes responses to at least four of five)
Regularly noticed wheezing, cough, phlegm, shortness of breath, or chest tightness
Persistent dry cough
Chest sounds wheezy or whistling (with cold or apart from cold or most days or nights)
Attack of wheezing with shortness of breath
Shortness of breath upon hurrying on level or slight hill
•Urticaria
(Yes response to at least one of following clinical profiles)
Frequent cutaneous wheals with local and/or generalized itching
Frequent cutaneous erythema with local and/or generalized itching
•Dermatitis
(Yes response to at least one of following clinical profiles)
Acute microvesiculated cutaneous eruptions with both local itching and flare
Chronic eczematous cutaneous lesions
Overlapping urticarilike and acute microvesiculated/chronic-eczematous cutaneous lesions
•Occupational rhinitis or asthma or urticaria/dermatitis
Diagnosis of rhinitis or asthma or urticaria/dermatitis
Symptoms not present before employment started
Yes response to at least two of three:
Symptoms improve or cease on weekends off
Symptoms improve or cease on vacations
Symptoms worsen on returning to work
•Chronic bronchitis
Cough and/or phlegm for most days
For 3 consecutive months or more
For 2 years or more
•Hypersensitivity pneumonitis
As previously confirmed in official occupational medical center by combination of clinical findings, radiographic abnormalities, pulmonary function tests, and immunologic tests
Timing of symptoms: symptoms of diseases were defined as "lifelong" when they occurred at any time from birth and "current" when they occurred at time of investigation or at least two times in preceding year. Chronic bronchitis, hypersensitivity pneumonitis, and occupational complaints were considered only when they were "current" symptoms.

Table 2. Frequency of lifelong and current respiratory and/or cutaneous symptoms (R/CS) in farmworkers grouped by results of skin prick test (SPT) for common allergens and *T. urticae*. In square brackets are reported patients with occupational disease

Clinical finding	SPT positive			SPT negative			Total	
	(n = 293)			(n = 667)			(n = 960)	
	n	%*	%†	n	%*	%†	n	%
Subjects with any lifelong R/CS	108	37	11.2	62	9.3	6.5	170	17.7
Rhinitis	106	36.2	11	16	2.4	1.7	122	12.7
Asthma	79	27	8.2	12	1.8	1.3	91	9.5
Urticaria	38	13	3.9	15	2.2	1.6	53	5.5
Dermatitis	27	9.2	2.8	9	1.3	0.9	36	3.7
Subjects with any current R/CS [occupational]	100 [44]	34.1 [15]	10.4 [4.6]	50 [2]	7.5 [0.3]	5.2 [0.2]	150 [46]	15.6 [4.8]
Rhinitis	91 [32]	31 [10.9]	9.5 [3.3]	2	0.3	0.2	93 [32]	9.7 [3.1]
Asthma	69 [23]	23.5 [7.8]	7.2 [2.4]	2	0.3	0.2	71 [23]	7.4 [2.4]
Urticaria	20 [10]	6.8 [3.4]	2.1 [1]	2 [1]	0.3	0.2 [0.1]	22 [11]	2.3 [1.1]
Dermatitis	25 [20]	8.5 [6.8]	2.6 [2.1]	1 [1]	0.1	0.1 [0.1]	16 [21]	1.7 [2.2]
Chronic bronchitis	2	0.7	0.2	44	6.6	4.6	46	4.8
Hypersensitivity pneumonitis	2	0.7	0.2	3	0.4	0.3	5	0.5

* Proportion of symptoms within SPT-positive or SPT-negative groups.

† Proportion of symptoms in total sample (n = 960).

Table 3. Odds ratios for different allergen skin reactivity in subjects with current occupational and nonoccupational complaints in entire sample of farmworkers ($n=960$). Odds for common allergen (CAL)-positive farmers to have *T. urticae* (TU)-positive SPT are also shown

	CAL + ($n=273$)	CAL – ($n=687$)	OR	CI	TU + ($n=58$)	TU – ($n=902$)	OR	CI
Farmers with any current symptoms (150)	88	62	4.8	3.3–6.9	30	120	7	4.0–12.1
Farmers with current occupational symptoms (46)	32	14	6.4	3.3–12.2	28	18	45.8	22.9–91.8
Farmers with current nonoccupational symptoms (104)	56	48	3.4	2.3–5.2	2	102	0.3	0.07–1.2
TU-positive farmers (58)	38	20	5.4	3.1–9.5	–	–	–	–

OR: odds ratios; CI: 95% confidence interval.

Of the 960 subjects studied, 273 (28.4%) were atopic as assessed by the CAL panel. The prevalence rate of atopy was 27.9% in males and 29% in females. However, when the number of subjects with an isolated positivity to TU was included, the total number of subjects displaying a positive SPT rose to 293 (30.5%); of these, 235 were only positive to CAL, 20 had an isolated positivity to TU, and 38 were positive to both CAL and TU. All subjects considered, 58 (6%) had positive SPT to TU (31 males; mean age = 29.6 ± 3.9 years).

A total of 103 (10.7%) farmers were reported to be working in pesticide-free “biological” greenhouses.

A total of 46 (4.8%) patients had occupational symptoms. All patients had suffered for more than 2 years, and their symptoms appeared or worsened only during work. Four patients were aware that tobacco leaves were responsible for their symptoms, while 22 other patients were able to associate their symptoms with contact with the red spider mite ($n=16$) or frequently handled fresh vegetables ($n=6$). The mean length of time as a farmworker, before the onset of

occupational symptoms, was 35.2 ± 14.9 months. Complete clinical data for skin-tested subjects are listed in Table 2.

Of the 46 patients with job-related complaints, 28 (60.9%) had positive SPT to TU, accounting for 2.9% of the entire examined population; 16 subjects had negative SPT to TU but positive SPT to different putative occupational allergens; the remaining two patients were shown to be SPT negative.

In the whole population, CAL sensitization was a significant risk factor for development of TU sensitization and nonoccupational as well as occupational symptoms (Table 3). In the same sample, TU sensitization carried the highest risk of occupational complaints, and no increased risk of nonoccupational complaints (Table 3). Furthermore, in farmworkers with positive SPT, the presence of occupational symptoms significantly predicted a positive SPT response to TU, whether isolated or associated with CAL, whereas the presence of nonoccupational complaints did not (Table 4).

Table 4. Results of multinomial logistic regression analysis to evaluate relationship between selected SPT-positive responses (dependent variable [CAL only = 0; ITU = 1; CALTU = 2]) and current symptoms (independent variable [absent = 0; occupational = 1; nonoccupational = 2])

	“Current” symptoms			Total
	Absent*	Nonoccupational	Occupational	
SPT-positive response				
ITU	7	1	12	20
CALTU	21	1	16	38
CAL only*	165	54	16	235
Total	193	56	44	293
Variable	Regression coefficient	P	OR	CI
ITU +				
Nonoccupational symptoms	-0.829 ± 1.080	NS		
Occupational symptoms	3.701 ± 1.079	<0.001	40.5	4.9–335.7
Intercept	-3.401			
CALTU +				
Nonoccupational symptoms	-1.928 ± 1.035	NS		
Occupational symptoms	3.989 ± 1.079	<0.0001	54	6.6–439.2
Intercept	-3.989			

ITU: isolated sensitization to *T. urticae*; CAL: sensitization to common allergen; CALTU: sensitization to both common allergens and *T. urticae*; OR: odds ratio; CI: 95% confidence interval; NS: not significant.

* Reference categories used for computed logistic regression analyses.

Table 5. Sensitization to *T. urticae* (TU) and/or common allergens (CAL), presence of occupational complaints in farmers ($n=960$) grouped by workplace (A). In part B, the length (months) of latency periods from job-related symptoms in both groups is shown

	Habitual workplace				<i>P</i> *
	Greenhouse (<i>n</i> =103)		Open field (<i>n</i> =857)		
	<i>n</i>	%	<i>n</i>	%	
Total farmers with SPT – (667)	65	63.1	602	70.3	NS
Total farmers with SPT + (293)	38	36.9	255	29.7	NS
CAL + and TU – farmers (235)	17	16.5	218	25.4	0.04
CAL- and TU + farmers (20)	8	7.8	12	1.4	0.0001
CAL + and TU + farmers (38)	13	12.6	25	2.9	< 0.0001
Total farmers with JRC (46)	19	18.4	27	3.1	< 0.0001
CAL – and TU – farmers with JRC (2)	2	1.9	–	–	0.01
CAL – and TU + farmers with JRC (12)	6	5.8	6	0.7	0.0007
CAL + and TU + farmers with JRC (16)	9	8.7	7	0.8	< 0.0001
CAL + and TU – farmers with JRC (16)	2	1.9	14	1.6	NS

B	Latency period (mean ± SD)	Latency period (mean ± SD)	<i>P</i> **
•Farmers with JRC (46)	24.6 ± 7.1	40.6 ± 11.1	< 0.0001
TU + farmers with JRC (28)	22.7 ± 5.5	41 ± 21.6	0.005

NS: not significant; SD: standard deviation; JRC: job-related complaints.

* By chi-square or Fisher's exact test.

** By independent sample t -test.

The number of patients with job-related complaints and the prevalence of TU sensitization were significantly higher ($P<0.0001$) in the greenhouse worker group than in farmers working in open fields (Table 5).

The length of latency periods for occupational complaints was significantly shorter in the greenhouse worker group than in farmers working in open fields ($P<0.0001$) (Table 5) and in CALTU+ subjects as opposed to ITU+ subjects ($P<0.0002$) (Table 6).

Occupational complaints and their distribution in farmers with different SPT responses are detailed in Table 7.

TU challenge test

During specific challenge tests, all TU-positive patients with previously reported occupational symptoms

Table 6. Effects of allergen-skin reactivity on length of latency periods (months) from occupational symptoms in farmers with occupational complaints

	Allergen skin reactivity					
	CAL			TU		
	Latency periods (mean $\pm$ SD)		P^*	Latency periods (mean $\pm$ SD)		P^*
	CAL +	CAL –		TU +	TU –	
All patients (46)	24.5 $\pm$ 7.4	36.9 $\pm$ 10.8	<0.0001	32.6 $\pm$ 10.9	23.3 $\pm$ 5.4	0.002
TU + patients (28)	26.4 $\pm$ 8.7	41.2 $\pm$ 9.6	0.0002	–	–	–
CAL + patients (32)	–	–	–	26.4 $\pm$ 8.7	22.6 $\pm$ 5.8	NS

CAL: common allergens; TU: *Tetranychus urticae*.

* By independent sample t -test; sd: standard deviation.

NS: not significant.

($n=28$) quickly manifested (18–60 min; mean 36.2 ± 13.6 min) the onset of the previously described complaints. Moreover, the two nonatopic patients with reported occupational cutaneous symptoms, and one ITU+ subject suffering from nonallergic and non-job-related perennial rhinitis exhibited erythema and wheals on the uncovered skin of their arms. Common antiallergic drugs easily controlled all symptoms, which completely resolved within 2.5 h of their appearance. None of the patients reported any late-phase allergic reactions.

The four patients with occupational rhinitis and asthma induced by tobacco (as previously assessed in another medical center) underwent TU challenge only, while in the other 12 TU-negative atopic patients with occupational complaints, after a negative challenge test to TU exposure, symptoms reappeared on exposure to the allergens to which they had displayed positive SPT (tomato in nine cases and celery in three cases).

The results of specific exposure tests and clinical/occupational characteristics of the examined subjects are listed in Table 8.

Bivariate correlation showed that seasonal rhinitis was the only significant defined clinical feature correlating with TU sensitization in farmworkers suffering from seasonal occupational complaints (correlation coefficient = +0.82; $P<0.0001$).

Discussion

To our knowledge, this is the first extensive cross-sectional survey on the prevalence of TU-induced

Table 7. Clinical features and SPT results in farmers with job-related complaints

Symptoms/signs (n)	SPT results				Total
	TU + and CAL –	TU + and CAL +	TU – and CAL +	TU – and CAL –	
All	12	16	16	2	46
Rhinitis	12	16	4	–	32
Asthma	7	8	8	–	23
Urticaria	4	6	–	1	11
Dermatitis	3	5	12	1	21

TU: *T. urticae*; CAL: common allergens.

immediate sensitization in an unselected and randomized sample of farmers living in a temperate area. Although the percentage of TU-positive subjects (6%; $n = 58$) among all active farmworkers was certainly low compared with that of subjects with sensitization to other allergens (24.5%; $n = 235$), this study shows that in this workforce the presence of seasonal, recurrent occupational complaints was associated with the risk of having TU allergy. Moreover, the percentage of TU-induced occupational complaints would have increased from 60.9% to 65.2% had we included the two cases of occupational, nonallergic contact urticaria that were shown to be induced by TU challenge. Consequently, had TU not been included in the allergen panel, 26.1% of subjects with occupational complaints (12 ITU + patients suffering from job-related complaints) would have eluded a diagnosis of allergic occupational disease, and causative agents of occupational complaints might

not have been diagnosed in 34.8% of subjects responsive to other allergens (16 CALTU + patients suffering from job-related complaints).

The observation that SPT reactivity to CAL was a significant risk factor for presence of skin reactivity to TU in farm workers is consistent with what was previously observed for a variety of other natural, high-molecular-weight, occupational allergens (17). In our population, however, this risk factor was less prominent than the one recently reported for latex allergens in health-care workers, among whom atopic subjects had a sixfold greater prevalence of latex sensitization than their nonatopic colleagues (18). In our case series, TU-positive patients with job-related complaints were shown to have statistically significant odds to be CAL + subjects. Moreover, the length of time as farmworkers before the onset of occupational symptoms was significantly shorter in CALTU + than ITU + patients. These data show that CAL skin reactivity was an important risk factor for manifestation of TU clinical reactivity as well as early development of TU-dependent occupational complaints.

The prevalence of TU skin sensitization, together with the prevalence of TU-positive farmers with occupational complaints and the length of latency periods from symptoms observed in the separated groups of greenhouse and open-field workers, indicated that habitual working in greenhouses was also a significant risk factor for development of TU sensitization/allergy.

Indeed, when our data were analyzed according to the specific workplace, the prevalence of TU sensitization was found to be similar to that recently reported in selected Spanish greenhouse workers (4) but appeared to be nearly fourfold lower than that reported in a sample of Korean apple-cultivating farmers (5). On the contrary, among all our cases of occupational asthma, we found a prevalence of TU-induced, and challenge-proven, occupational asthma that was at least twice as high (65%) as the prevalence of Korean farmers with reported work-related asthmatic symptoms and positive SPT to TU (27%). Finally, our overall prevalence of asthmatic subjects with positive SPT to TU (1.5%) was nearly threefold lower than the one reported in Spanish greenhouse workers (7.2%). These differences may be determined, at least in part, by different climate and

Table 8. Clinical/occupational profiles, and SPT and challenge test results (+/–) in 91 farmers (46 of them with current, job-related complaints)

Patient no.	Clinical profiles*	SPT for allergens			Challenge results	
		TU	Common	Occupational	TU	POA
1–3	R-U	+	+	–	+	nd
4–5	R-U	+	–	–	+	nd
6–8	R-A-U	+	+	–	+	nd
9–10	R-A-U	+	–	–	+	nd
11–15	R-D	+	+	–	+	nd
16–18	R-D	+	–	–	+	nd
19–23	R-A	+	+	–	+	nd
24–28	R-A	+	–	–	+	nd
29–32	A-D	–	+	Tomato	–	+
33–36	D	–	+	Tomato	–	+
37	D	–	+	Tomato	–	+
38–40	D	–	+	Celery	–	+
41–44	R-A	–	+	Tobacco	–	+
45	U	–	–	–	+	nd
46	D-U‡	–	–	–	+	nd
47	R†-U‡	+	–	–	+	nd
48–54	Healthy	+	–	–	–	nd
55	R†	+	+	–	–	nd
56–76	Healthy	+	+	–	–	nd
77–91	Healthy	–	–	–	–	nd

TU: *T. urticae*; R: rhinitis; A: asthma; D: dermatitis; U: urticaria; nd: not done; †: TU-induced contact urticaria without specific IgE mediation; POA: putative occupational allergens.

* Current and challenge-confirmed occupational symptoms except when indicated.

† Current but nonoccupational (challenge) proven symptoms.

‡ Noncurrent but challenge-induced symptoms.

specific job-related environmental TU concentrations, and by the different prevalence of atopic subjects and farmers with reported work-related asthma in our unselected sample and in the selected Korean and Spanish samples, respectively.

With regard to specific clinical features, a history of recurrent summer–autumn occupational rhinitis was shown to be the best clinical correlate of TU allergy in our series of patients with occupational complaints, as defined by a sensitivity of 0.85, a specificity of 1.0, a predictive positive value of 1.0, a negative predictive value of 0.77, and an overall accuracy of 0.90.

In our opinion, the reported clinical observations may have important practical implications. In fact, in the EU and in the USA, the total agricultural labor force numbers 7 600 000 and 2 979 000, respectively (data obtained from the Food and Agriculture Organization [FAO], Faostat database). Considering these figures, the number of farmworkers at risk of developing a TU-related disease and having an incorrect diagnosis is

estimated to be about 650 000. In addition, considering the prevalence data of TU sensitization reported in Korea, a considerable number of farmers living in tropical/subtropical climates can be estimated to be exposed to this allergic occupational risk.

In summary, the present study shows that occupational seasonal symptoms, and especially rhinitis, in farmworkers can be related directly to the presence of TU allergy. This simple information may be very useful to physicians, as this condition can be easily and inexpensively explored with a specific TU SPT. In this way, patients can be advised on how to take precautionary measures in the high-risk season, probably resulting in a decrease in national public health expenses and in hours of work lost.

Clearly, further prospective studies are necessary to define exactly the role of TU as an occupational allergen in farmworkers and the mechanisms that regulate the development of sensitization to this phytophagous mite.

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