OCCUPATIONAL ALLERGY AMONG TABLE GRAPE FARM WORKERS IN SOUTH AFRICA

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SUMMARY

Recent studies among farm workers suggest that excessive pesticide use, as well as biological factors such as outdoor mites, may be responsible for asthma symptoms experienced by workers. Grape farms, in contrast to fruit farms, have not been previously investigated for occupational respiratory allergy to spider mites. A cross-sectional study was conducted on 207 workers employed in nine table grape farms, investigating allergic sensitisation to common inhalants and occupational allergens. Common work-related symptoms included wheezing (26%), rhinoconjunctivitis (24%), urticaria/skin symptoms (15%) and doctor-diagnosed asthma present in 9% of subjects with work-related symptoms. These work-related symptoms were significantly higher ($p < 0.001$) in the orchards compared with the stores. The highest prevalence of positive skin-prick tests was observed to spider mite *(Tetranychus urticae)* (23%), followed by house-dust mite *(Dermatophagoides pteronyssinus)* (16%) and cockroach *(Blatella germanica)* (12%). This study has demonstrated that spider mites such as *T. urticae* may be important outdoor allergens responsible for allergic symptoms among table grape farm workers in the Western Cape province of South Africa.

INTRODUCTION

Asthma and other respiratory health problems among farmworkers may be due to excessive agrichemical use, biological factors (animal, vegetable or micro-organisms and their contaminants such as endotoxins) or in all likelihood a combination of both. Recent studies demonstrate an increased prevalence of chest complaints and wheezing among workers exposed to pesticides (paraquat and organophosphates) in the Western Cape province of South Africa and in the USA.[1,2]

There have been few epidemiological studies among workers on fruit farms that have focused on the factors determining the incidence/prevalence of occupational allergy and asthma in specific exposure settings, the spectrum of allergens involved, and the patterns of immunological responses observed. Isolated case reports of occupational allergies and asthma due to micro-organisms such as *Botrytis cinerea,* a mould commonly found on grapes, and plant allergens such as the wall rocket *(Diplotaxis erucoides),* crucifera plant or vine pollen, *Vitis vinifera,* as well as arthropods such as insects (e.g. fruit moths) and mites (e.g. storage mites) have been reported.[3-5] Farm workers, particularly on fruit farms, have been frequently found to be sensitised to a new allergen source, spider mites.[6,7] Jee *et al.* [8] demonstrated that this mite may also be an important allergen in asthmatic non-farmers living around pear orchards. Some of the spider mite allergens can cross-react with other storage and domestic mite species; however, the majority of allergens appear to be species-specific.[9]

Spider mites belong to the family of phytophagous outdoor mites as opposed to the common indoor house-dust mite that lives on human debris. *Tetranychus urticae* is a microscopic mite (commonly known as red spider) which parasitises fruit trees, herbaceous plants and greenhouse crops worldwide (Fig. 1).[10] Spider mites rapidly develop injurious populations in spring, damaging fruit leaves and in some cases causing defoliation.[11] Although predaceous mites attack spider mites, the predator complex does not usually control spider mites, particularly when spray programmes of organophosphates or sulphur upset natural control (Fig. 2).[12]

Fig. 1. Two-spotted spider mite, Tetranychus urticae *Koch (Fasulo TR, Denmark HA) – brown to orange red in colour and 0.4 mm in length.*

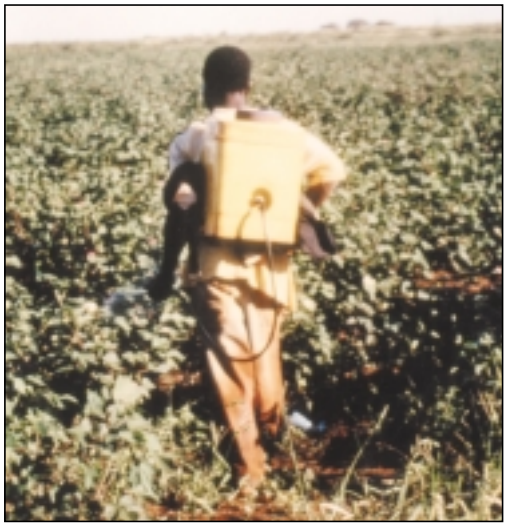

Fig. 2. Pesticide crop sprayer on a table grape farm.

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The spider mite, *T. urticae,* has been considered the cause of occupational IgE-mediated disease in greenhouse and outdoor farmworkers.[13-15] Reunala *et al.* [16] first described allergic reactions to *T. urticae* in two patients suffering from rhinitis, conjunctivitis and contact urticaria, who worked in a greenhouse. A study of patients working in a fruit-growing area demonstrated positive sensitisation to spider mite in workers with clinical symptoms (rhinitis, conjunctivitis, erythema and asthma).[17] Subsequently, Delgado *et al.*[14] described a case of *T. urticae*-induced occupational asthma and rhinoconjunctivitis confirmed by specific bronchial challenge.[14] Recently, cross-sectional studies have demonstrated that spider mites such as the European red mite *(Panonychus ulmi)* and the two-spotted spider mite *(T. urticae)* are important allergens in the development of work-related asthma and rhinitis symptoms.[7,18,19] *T. urticae* has also been shown to be directly responsible for recurrent dermatitis, caused by a different immune-mediated mechanism, in farm workers.[20]

A cross-sectional study conducted among citrus farm workers in Korea found a prevalence of sensitisation to spider mite of 16.5%, and 12.1% were diagnosed as having occupational asthma.[19] Another cross-sectional study demonstrated that *P. ulmi* and *T. urticae,* common apple leaf spider mites, were the most common sensitising allergens in 725 apple farmers, of whom more than 5% showed isolated allergic skin response to the spider mites.[7] Navarro *et al.*[13] found that sensitisation to spider mite was more common in atopic greenhouse workers than in non-atopic workers.[13] It was shown that 19% of the sensitised workers had allergic rhinitis symptoms and 7% had asthma symptoms.

The introduction of pesticides to eliminate fruit moths in the fruit-cultivation industry has resulted in an increasing number of spider mite populations that are not well controlled by current predator complexes. There have been reports of failure of chemical control, and high levels of resistance to miticides have also been recorded.[21,22] The farming of wine and table grapes is one of the biggest sources of income in the Western Cape with about 3 000 farms employing over 50 000 workers.[23] Vineyards, in contrast to fruit farms (citrus and apple), have not been previously investigated for occupational allergy and asthma associated with spider mites. The intensive use of anti-mite pesticides in table grape farms made this group of workers the preferred target group. The main objective of this study was to determine the spectrum of allergic sensitisation to various allergens and the prevalence of work-related allergic health outcomes (rhinoconjunctivitis, urticaria /dermatitis and asthma) among workers on table grape farms.

METHODOLOGY

A cross-sectional study was conducted on 207 workers employed in table grape farms around the Hexriver Valley near Worcester in the Western Cape. Suitable vineyards had already been identified by researchers for a study on pesticide use on these farms. The workers for the study on spider mite allergy were randomly selected from 9 farms identified by the pesticide study. The Research Ethics Committee of the University of Cape Town approved the study. Informed written consent was sought prior to any investigations being performed on any of the workers.

The main study instruments included a questionnaire and skin-prick testing. Each worker answered a standard abbreviated questionnaire based on the European Community Respiratory Health Survey questionnaire, slightly modified for local conditions.[24] This was administered by a trained interviewer in the language of the worker. Questions covered work history, job task, symptoms at work, and medical history including medication use. Symptoms were considered to be work-related if they were reported by the workers as being associated with working in the farm orchard or storeroom. Symptoms elicited included wheezing, rhinoconjunctivitis, redness, itching and/or eczema of the skin and asthma in the past year. Asthma was defined as a positive answer to the following question: *Has a doctor ever diagnosed you as having asthma?*[25]

Skin-prick testing was performed on all workers using commercially available extracts of common inhalant allergens (ALK-Abelló, A/S, Horsholm, Denmark) such as house-dust mite *(Dermatophagoides pteronyssinus),* mouldmix *(Cladosporium herbarum, Alternaria alternata, Fusarium),* bermuda grass *(Cynodon dactylon),* rye grass *(Lolium perenne),* cat *(Felis domesticus)*, treemix (False acacia, Live oak, Olive, White birch, Ash) *and* cockroach *(Blatella germanica).* Potential occupational allergens tested included grape mould *(Botrytis cinerea)* and an in-house generated extract of spider mite, *T. urticae.* The latter was kindly provided by Dr Yoon-Keun Kim and Dr Yoon-Seok Chang (Department of Internal Medicine, Seoul National University College of Medicine, Korea). Histamine dihydrochloride was used as a positive control and a diluent of glycerol/sodium chloride as a negative control. Areas of erythema were traced on clear tape that was stored for later verification. A positive test was regarded as a wheal read 15 minutes after testing that had a diameter ≥ 3 mm larger than the negative control. The examiner was blinded to the exposure status of each worker. A subject was considered to be atopic if there was a positive skin reaction to one or more common inhalant allergens.[26] Occupational sensitisation to spider mite was defined as positive skin-prick test to *T. urticae.* Pregnant workers and those with acute asthma symptoms were not eligible for skin-prick testing.

Statistical analysis was performed using STATA version 6 for univariate, bivariate and multivariate analysis of the outcomes of interest in relation to the predictors of interest. The *chi*-square statistic was used for categorical data.[27]

RESULTS

The demographic characteristics of the study population are outlined in Table I. The proportion of males to females in this study population was almost the same, with an average employment duration of 15 years on grape farms. Skin-prick tests were performed on 197 subjects only (4 were pregnant, 6 complained of tight chest). A further 7 subjects were excluded from the data analysis since one showed demographism, and 6 did not react to the positive control. The prevalence of

Table I. Demographic characteristics of table grape farm workers in the Western Cape

Demographic characteristics (*N* = 207)	
Age (years)	36 ± 11
Gender (F:M)	1.1 : 1
Employment status (% permanent)	86
Employment duration at current farm (years)	10 ± 8
Employment in current job (years)	9 ± 8
Employment duration at other grape farms (years)	5 ± 5
Crop sprayers (%)	12
Asthma medication use (%)	7
Atopic status (%)	25

work-related wheezing (26%) was much higher than other allergic symptoms and 9% of workers reported physician-diagnosed asthma. When compared with general symptoms, the prevalence of work-related symptoms was almost comparable for wheezing (26/30), rhinoconjunctivitis (24/25) and urticaria/skin symptoms (15/20). The prevalence of work-related symptoms was higher when working in the orchards compared with working in the stores (*chi*-square test, $p < 0.001$).

The prevalence of sensitisation to common inhalants is shown in Table II. Sensitisation to spider mite was much higher (23%) compared with house-dust mite (16%), although not statistically significant ($p = 0.09$). There were 13 workers (9%) who demonstrated monosensitisation to spider mite. Surprisingly few workers demonstrated sensitisation to the grape mould *(B. cinerea).*

The prevalence of allergic symptoms associated with sensitisation to spider mite was highest for wheezing (7%), followed by rhinoconjunctitivitis (6%) and urticaria (4%) as shown in Table III. This was similar to house-dust-mite-associated work-related symptoms. However, sensitisation to house-dust mite was poorly correlated with spider mite sensitisation ($r = 0.49$, $p < 0.001$, Spearman).

Table II. Prevalence of positive skin-prick test results to common aeroallergens and potential occupational allergens among table grape farm workers in the Western Cape

Allergen	Prevalence of sensitisation (% SPT positive) (*N* = 190)
Common inhalants	
House/dust mite *(D. pteronyssinus)*	16
Cockroach *(B. germanica)*	12
Rye grass *(Lolium perenne)*	11
Bermuda grass *(Cynodon dactylon)*	6
Mouldmix *(Cladosporium herbarum, Alternaria alternata, Fusarium)*	3
Treemix (False acacia, Live oak, Olive, White birch, Ash)	3
Cat *(Felis domesticus)*	2
Occupational allergens	
Spider mite *(Tetranychus urticae)*	23
Grape mould *(Botrytis cinerea)*	2

Table III. Prevalence of work-related spider mite and house-dust mite allergy among table grape farm workers in the Western Cape

Symptom	Number and prevalence (%) (*N* = 190)		p value*
	Spider mite allergic	House-dust mite allergic	
Allergic sensitisation	44 (23%)	31 (16%)	0.09
Wheezing	13 (7%)	13 (7%)	1.00
Rhino-conjunctivitis	11 (6%)	12 (6%)	0.83
Urticaria/skin symptoms	7 (4%)	8 (4%)	0.79
Doctor-diagnosed asthma	4 (2%)	4 (2%)	1.00

* *Chi*-square test

When stratifying according to *T. urticae*-allergic (TU-allergic) status, 13 (72%) of the 18 TU-allergic subjects were atopic, compared with 35 (20%) of 172 in the non-TU-allergic group. Workers who were TU-allergic were therefore more likely to be atopic than those who were NTU-allergic ($p < 0.001$).

DISCUSSION

In this study among table grape farm workers, a high prevalence of sensitisation to *T. urticae* (23%) was found, with 7% of workers demonstrating isolated positive skin responses to spider mite. This is much higher than findings in studies among citrus farmers (16.5%) but comparable with those in apple farmers (5%) in Korea.[7,19] Considering the existence of other sources of allergens on farms, sensitisation to *T. urticae* among table grape farm workers was found to be higher than to allergens such as the common house-dust mite. This could be due to the nature of the work involved, in that outdoor farming promotes the development of spider mite populations due to optimal temperature and humidity conditions. This could also explain the increased prevalence of work-related symptoms when subjects were working in the orchard compared with working indoors in the stores. Furthermore, in recent years *T. urticae* has proliferated extraordinarily in the South African farm environment, probably as a result of its resistance to common pesticides and the disappearance of natural predators.[12,13,21,22]

Physician-diagnosed asthma was reported by 9% of workers, which is similar to current estimated prevalences of 5 - 10% for adult asthma. Definitions of asthma often include clinical and/or physiological features such as reversible airways narrowing, hyperresponsiveness and inflammation. Since these tests require major logistical arrangements especially when studying farming activities where workers are widely dispersed, questionnaires used in epidemiological settings can produce equally valid results.[28] Questionnaires usually ask for 'physician-diagnosed asthma', the definition which was adopted in our study. The validity of self-reported asthma in questionnaires has been estimated by Toren *et al.*[25] The sensitivity varies between 48% and 100%, but the specificity is high, especially for the question on 'physician-diagnosed asthma' (specificity ≥ 99%).

Table grape farm workers in the Western Cape reported a higher prevalence (26%) of work-related wheezing in the past year compared with the 19% prevalence recently reported by pesticide applicators in the USA.[1] Wheezing was also the most frequent symptom reported in both *T. urticae* and house-dust mite allergic workers. However, the low level of correlation of sensitisation between the two groups suggests that this cannot be explained purely through cross-reactivity. In fact, studies demonstrate that the majority of allergens appear to be species-specific.[9] These findings do however demonstrate that spider-mite-related allergic symptoms appear to be as common as house-dust mite allergies, especially for outdoor work-related activities. It is also evident that the commonly held view that the grape mould *(B. cinerea)* is an important allergen in grape handling is not borne out by findings in this study. The contribution of vine pollen sensitisation to allergic symptoms is another factor to consider in explaining the allergic symptoms reported.[4] This, however, was not assessed since no commercial extracts were available at the time of the study.

In this study, at least 59% (26/44) of the workers with a positive skin-prick test to *T. urticae* were asymptomatic. The clinical significance of asymptomatic positivity is unknown, but this may identify a group at risk of becoming symptomatic in the future. Furthermore,

since the study was conducted in winter, when the environmental exposure to spider mite is known to be low, this may also have contributed to this finding. As with most cross-sectional studies, this may be indicative of a healthy worker effect in operation, in that symptomatic workers may have left the job and sought alternative employment.

In this study, atopy was significantly associated with allergy to *T. urticae.* This confirms previous studies demonstrating atopy as a predisposing factor to *T. urticae* hypersensitivity.[13]

CONCLUSION

Allergens are ubiquitous and are present in different concentrations in various environments, including farm settings. The present study revealed that *T. urticae* was the most common sensitising allergen and may be an important outdoor allergen among table grape farmworkers in the Western Cape of South Africa. These allergens should therefore be included in the skin-prick test panel for evaluating patients living close to fruit farms or farm workers on fruit farms presenting with allergic symptoms.

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