

# ENVIRONMENTAL DETERMINANTS OF WORK-RELATED ASTHMA SYMPTOMS ON TABLE GRAPE FARMS – INDOOR DOMESTIC MITES OR OUTDOOR SPIDER MITES?

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It is well recognised that domestic mites are an important cause of allergy and asthma worldwide.<sup>1</sup> Among the domestic mites, both house-dust mites and storage mites have been implicated in causing allergic symptoms among both farming and non-farming populations, despite farmers showing relatively lower prevalences of sensitisation to most common inhalants.<sup>2</sup> In the occupational context, house-dust mites have been implicated in causing allergic symptoms and asthma among woodworkers, avian mites among poultry workers and storage mites among bakery and grain mill workers.<sup>3</sup> More recently, outdoor mites such as spider mites have emerged as an important allergen, causing allergic diseases, including asthma, among farming as well as non-farming populations.<sup>4</sup> The farming population is unique in that domestic and outdoor mites may both be important sources of allergens as most workers work and live on the farm, thereby blurring the distinction between occupational and non-occupational factors that contribute towards allergic symptoms and asthma.

## THE MITE FAMILY

The family of mites can be basically described as belonging to the phylum Arthropoda, class Arachnida and order Acari (Table I).<sup>4,5</sup> Among this family there are two major sub-categories called Astigmata (house-dust mite and storage mites) and Prostigmata (spider mites). Studies on the ecology and distribution of domestic mites and their contribution to allergic diseases indicate that they are generally found in homes located in geographical regions with more humid climates.<sup>6</sup> Spider mites on the other hand are outdoor phytophagous mites that colonise leaves of fruit trees, herbaceous plants and greenhouse crops causing damage to fruit leaves and in some cases defoliation.<sup>4</sup> Ecological surveys indicate that while the European red mite (*Panonychus ulmi*) and the two-spotted spider mite (*Tetranychus urticae*) are commonly found on apple farms, *T. urticae* is the most common pest found on pear farms, in greenhouses and on herbaceous plants.

**Table I. Family relationship between house-dust mites, storage mites and spider mites**

Suborder	Family	Genus	Species
Astigmata	Pyroglyphidae (house-dust mites)	<i>Dermatophagoides</i>	<i>D. pteronyssinus</i> <i>D. farinae</i> <i>E. maynei</i>
		<i>Euroglyphus</i>	
		<i>Glycyphagus</i>	<i>G. domesticus</i>
	Glycyphagidae (storage mites)	<i>Lepidoglyphus</i>	<i>L. destructor</i>
		<i>Blomia</i>	<i>B. tropicalis</i>
		<i>Acarus</i>	<i>A. siro</i>
Prostigmata	Tetranychidae (spider mites)	<i>Tyrophagus</i>	<i>T. putrescentiae</i>
		<i>Tetranychus</i>	<i>T. urticae</i>
		<i>Panonychus</i>	<i>P. ulmi</i> <i>P. citris</i>

Adapted from Kim YK et al, *J Allergy Clin Immunol* 1999; **104**:1285-1292

The citrus red mite (*P. citris*) is most commonly found on citrus farms.<sup>4</sup>

The introduction of pesticides to eliminate fruit moths in the local and international fruit cultivation industry has resulted in an increasing number of spider mite populations that are not well controlled by most predator mite complexes.<sup>7</sup> There have been reports of failure of chemical control with high levels of resistance to miticides recorded.<sup>8</sup> Surveys on the ecology and distribution of outdoor mite populations in the Western Cape indicate that spider mites are important pests encountered in apple orchards, with *T. urticae* and *P. ulmi* commonly found in the Elgin area, while *T. urticae* is predominant in the Ceres and Langkloof areas.<sup>9</sup>

## EPIDEMIOLOGICAL STUDIES OF SPIDER-MITE-RELATED ALLERGY AND ASTHMA

There have been few international studies that have investigated the prevalence and risk factors for allergic sensitisation and related adverse health outcomes among working populations. A cross-sectional study of citrus farm workers in Korea reported a prevalence of sensitisation to spider mite of 16.5%, with 12.1% having been diagnosed with occupational asthma.<sup>10</sup> Another cross-sectional study on apple farms demonstrated that *P. ulmi* and *T. urticae* were the most common apple leaf spider mites causing isolated allergic skin responses in 725 apple farmers.<sup>11</sup> Studies in Spain reported a 25% prevalence of sensitisation to spider mite *T. urticae* among greenhouse workers, with sensitisation being significantly associated with atopic status.<sup>12</sup> In this study 19% of sensitised workers had allergic rhinitis symptoms and 7% had asthma symptoms. More recently epidemiological studies have demonstrated that spider mites are also important allergens causing or aggravating asthma and rhinitis symptoms among adults and children living around citrus and pear farms in Korea.<sup>4</sup>

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## THE SOUTH AFRICAN STUDY OF TABLE GRAPE FARMS IN THE HEX RIVER VALLEY

The farming of wine and table grapes is one of the biggest sources of employment in the Western Cape, employing over 50 000 workers on approximately 3 000 farms.<sup>13</sup> Vineyards in contrast to other fruit farms (citrus, apple and pear) have not been previously investigated for occupational allergy and asthma due to spider mites. Since these farms are located within the same geographical region as apple farms, the ecological distribution of spider mites in these vineyards was considered in all likelihood to be very similar to that on apple farms. Furthermore, the extensive use of anti-mite pesticides in table grape farms as opposed to wine grape farms made this group of workers the preferred target group for further investigations.

A cross-sectional study was conducted on 207 workers employed on table grape farms around the Hex River Valley near Worcester in the Western Cape.<sup>14</sup> The average duration of employment on these grape farms was 15 years, with 12% of workers involved primarily in pesticide crop spraying (Fig. 1). The study found that the prevalence of work-related wheezing (26%) and ocular-nasal symptoms (24%) was more common than urticaria/skin symptoms (15%). Nine per cent of workers reported physician-diagnosed asthma. Importantly, work-related symptoms were more prevalent when workers were working in orchards than in the store-rooms ( $p < 0.001$ ).

The prevalence of atopy, as determined by a positive skin-prick test to one or more common inhalants, was relatively lower (25%) among these vineyard farm workers compared with other working populations in the Western Cape (36% among seafood processing workers and 45% among grain mill workers).<sup>15,16</sup> Surprisingly, skin reactivity to spider mite *T. urticae* was more common (22%) than to house-dust mite (16%); 7% were sensitised to spider mite only. However, mite-specific IgE determinations demonstrated the highest prevalence of elevated IgE levels against house-dust mite (20%) followed by storage mite (13%) and spider mite (6%) (Fig. 2). The study concluded that the overall prevalence of spider mite allergy (work-related allergic symptoms and sensitisation to *T. urticae*) was 9.5%, with respiratory allergy (4-6%) more common than skin allergy (1-3%).

Despite only 14% of the 44 workers with positive skin reactivity to spider mite having elevated specific IgE levels, a statistically significant but modest correlation was demonstrated between these two indices of allergic sensitisation (Spearman  $R = 0.26$ ;  $p < 0.001$ ), indicating that the skin-prick test had a higher degree of sensitivity but lacked the specificity of the specific serum IgE levels (Table II). The findings of this study



Fig. 1. Pesticide crop sprayers on a table grape farm in the Hex River Valley of the Western Cape (Occupational and Environmental Health Research Unit picture archives).

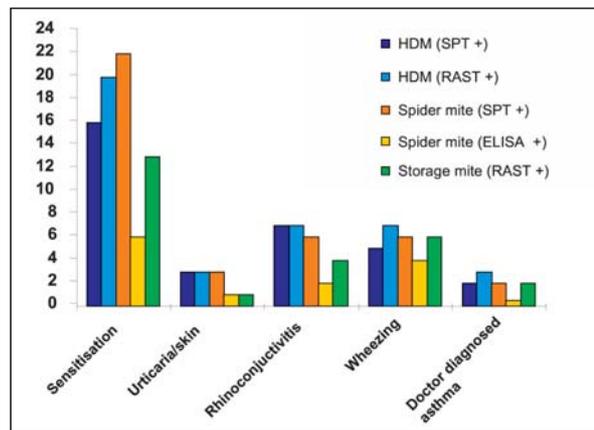


Fig. 2. Prevalence (%) of mite allergy among table grape farm workers in the Western Cape (N = 207), 2002.

point to the need to better define the predictive value of *T. urticae* specific IgE on symptom occurrence as suggested by Gargano *et al.*<sup>17</sup> Furthermore, while house-dust mite RAST was strongly correlated with storage mite RAST (Spearman  $R = 0.71$ ;  $p < 0.001$ ) it was only modestly correlated with spider mite ELISA (Spearman  $R = 0.28$ ;  $p < 0.001$ ). This can be explained by the high degree of cross-reactivity demonstrated between the domestic house-dust mites and storage mites, since they belong to the same phylogenetic sub-order called Astigmata (Table I). On the other hand, RAST inhibition studies have demonstrated limited cross-reactivity between spider mites and house-dust mites owing to few commonly shared allergenic determinants since they belong to different sub-orders.<sup>18</sup>

**Table II. Correlations between sensitisation to various mites among table grape farm workers in the Western Cape (n=207), 2002**

Mite	R	p value
HDM (SPT) vs HDM (RAST)	0.70	<0.001
HDM (SPT) vs storage mite (RAST)	0.45	<0.001
HDM (RAST) vs storage mite (RAST)	0.71	<0.001
HDM (SPT) vs spider mite (ELISA)	0.19	0.011
Spider mite (ELISA) vs storage mite (RAST)	0.25	<0.001
Spider mite (ELISA) vs spider mite (SPT)	0.26	<0.001
HDM (RAST) vs spider mite (ELISA)	0.28	<0.001

R - Spearman's Regression coefficient; HDM - house-dust mite; SPT - skin-prick test; RAST - radio-allergosorbent test; ELISA - enzyme-linked immunosorbent assay.

## RISK FACTORS FOR WORK-RELATED SYMPTOMS AND ASTHMA AMONG TABLE GRAPE FARM WORKERS

Various studies have shown that asthma and other respiratory health problems among farm workers may be either due to excessive agricultural use or biological factors (animal, vegetable or micro-organisms and their contaminants such as endotoxins), or in all likelihood a combination of both.<sup>19</sup> Recent studies demonstrate an increased prevalence of chest complaints and wheezing (19%) among workers exposed to pesticides (paraquat and organophosphates).<sup>20,21</sup> Since the current Hex River Valley study demonstrated an even higher prevalence (26%) of work-related wheeze among table

**Table III. Risk factors for work-related symptoms among table grape farm workers in the Western Cape (n=207), 2002**

Outcome	Predictor	Prevalence odds ratio	Confidence interval	p value
Urticaria/skin	Pesticide crop sprayers	3.42	1.00 - 11.66	0.050
Ocular-nasal	Male gender	1.93	1.01 - 3.72	0.048
	Pesticide crop sprayers*	3.49	1.31 - 9.31	0.012
	House-dust mite (SPT)*	3.17	1.37 - 7.33	0.007
	House-dust mite (RAST)*	2.42	1.09 - 5.32	0.029
Wheeze	Age	1.03	1.00 - 1.06	0.031
	Spider mite (ELISA)*	5.78	1.75 - 19.05	0.004
	Storage mite (RAST)*	2.39	1.02 - 5.59	0.044

\*Adjusted for age and gender

grape farm workers, it sought to identify the potential environmental risk factors for various work-related symptoms reported.<sup>14</sup> The follow-up study found that pesticide crop sprayers were more likely (OR=3.4) to report work-related skin symptoms, including urticaria symptoms (Table III). Workers who were sensitised to house-dust mite (OR=3.2) or pesticide crop sprayers (OR=3.5) were more likely to report work-related ocular-nasal symptoms. On the other hand, workers with work-related wheeze were more likely to have elevated specific IgE levels to spider mite (OR=5.8) and to a lesser extent to storage mite (OR=2.4).

These findings suggest that spider mite, *T. urticae*, could be considered the most important mite allergen responsible for work-related asthma symptoms among table grape farm workers in the Western Cape. The contribution of storage and possibly house-dust mite towards work-related asthma symptoms needs to be investigated further for probable cross-reactivity to spider mite. Further studies need to examine more closely the relationship between sensitisation to spider mite and excessive pesticide use as a mechanism for work-related asthma symptoms independent of the direct irritant effects of pesticides in relation to skin and ocular-nasal symptoms observed in this study.

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