

Seasonal Variation of Allergenic Acarofauna From the Homes of Allergic Rhinitis and Asthmatic Patients

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Abstract

House dust mites (HDMs) play positive role in causing various kinds of allergic manifestations such as allergic rhinitis (AR), asthma, dermatitis, and urticaria. HDMs are prevalent in temperate regions but various studies have shown the prevalence of HDMs in tropical and subtropical countries. The present study was conducted from March 2015 to February 2016. During the study period, a total of 500 dust samples were collected from 125 homes of 125 patients suffering from AR and asthma. From these 500 dust samples, 466 samples were found to be positive for mites. The year was divided into three climatic classes, i.e., CCL I (March, April, May, June), CCL II (July, August, September, October), and CCL III (November, December, January, February). A total of 7,710 mites were collected, from which 2,902 (37.63%) mites were found in samples collected during rainy season, i.e., CCL-I, 3,728 (48.35%) mites were found in samples collected during summer season, i.e., CCL-II and only 1,080 (14.01%) mites were found in samples collected during winter season, i.e., CCL-III. Total 7,710 mite specimens were isolated with 7,404, i.e., 96.03% were only from the hypoorder Astigmata, 240, i.e., 3.11% from suborder Prostigmata, 46, i.e., 0.60% from order Mesostigmata, and 20, i.e., 0.26% from suborder Oribatida. The present study indicates that *Dermatophagoides pteronyssinus* (Trouessart 1897) (Astigmata) was most abundant and frequently found allergenic mite species followed by *D. farinae* (Hughes 1961), *D. microceras* (Griffiths and Cunnington 1971), *Acarus siro* (Linnaeus 1758), *Tyrophagus putrescentiae* (Schrank 1781), *Lepidoglyphus destructor* (Schrank 1781), *Euroglyphus maynei* (Cooreman 1950), *Cheyletus*, Mesostigmatic, and Oribatida mites.

Key words: allergic rhinitis, asthma, carpet, climatic classes, house dust mites

Introduction

House dust mite (HDM) allergen exposure is a major risk factor for the development (Plattis-Mills and De Weck 1989; Sporik et al. 1990, 1992) and provocation (Sporik et al. 1992, Marks et al. 1995, Peat et al. 1996) of asthma and allergic rhinitis (AR) in many countries. HDMs have a well-established causal role in patients with persistent allergic respiratory diseases, such as AR and allergic asthma (AA) (Plattis-Mills 1992, Sporik et al. 1992). These atopic diseases lead to increased burden of diseases and health care costs, particularly in patients with uncontrolled or poorly controlled diseases (Masoli et al. 2004, Canonica et al. 2007). AR is a nasal disorder induced by immunoglobulin E (IgE)-mediated immune response and characterized by symptoms including rhinorrhoea, sneezing, nasal obstruction, and itching (Bousquet et al. 2008). It is one of the most common atopic diseases all over the world.

Asthma can be more severe in subjects with AR compared with those without AR (Dixon et al. 2006). Sensitization to specific

allergens can make asthma more difficult to control. For certain allergens, the combination of sensitization and exposure to high levels of the allergen can decrease asthma control (Gruchalla et al. 2005; Rosenstreich et al. 1997).

Many species of mites are the sources of potent allergens that sensitize and induce IgE-mediated allergic reactions in humans. Most of the mite allergens are proteins, and the allergic response mechanism to these allergens is the same as it is for allergens from other biological sources, such as plant pollens, moulds, and foods (Arlian 2001).

HDMs belonging to the subclass acari are members of arachnids. They are difficult to see with naked eye as their body size is approximately 100–400 µm. In houses, they are found in carpets and fabric-covered furniture, in particular, in living rooms and in beds, pillows, sheets, comforters, and carpets close to the bed in bedrooms. In general, the term “house dust mites” is used to describe the mite species of *Dermatophagoides pteronyssinus*, *D. farinae*, and *Euroglyphus*

maynei, which belong to the family Pyroglyphidae and continuously live in house dust. These mites transform from the egg stage to the adult stage within 3 to 4 wk under humid conditions at temperature of 25–30°C. The average lifetime of adult mites is 4–6 wk, and every female mite produces approximately 40–80 eggs during this time, which helps maintain this population (Colloff 2009).

Different environmental parameters like temperature, relative humidity, and rainfall play determinant role in maintaining mite population in the patients dwelling. Considerable variations within and between different homes have shown that factors such as age of home, floor level, ventilation, orientation, or living habits of the occupants, may contribute to the differences in indoor humidity that influence the growth conditions of mites (Korsgaard 1998, Arlian *et al.* 2002). Mites living in human areas occur most frequently on floors and in mattresses (Evans 1992). The relative humidity of that place determines the population of mites. In humid regions, all the homes contain the large number of dust mites but on the other hand in the dry climates fewer homes contain dust mites and the level of mite population and allergen is also low. However, by raising indoor humidity through the usage of evaporative coolers may lead to facilitate the mite survival.

The prevalence of these allergies is increasing day by day and very few studies have been done in India. Therefore, this study was carried out to determine the seasonal variation of allergenic acarofauna from the homes of patients suffering from AR and asthma.

Materials and Methods

The study was conducted on 125 patients suffering from AR and asthma who visited ENT department of Rajindra hospital, Patiala, from March 2015 to February 2016. All patients were subjected to full ENT examination by Dr. Baldev Singh. Patients were selected based on symptoms of sneezing, watery rhinorrhoea, nasal obstruction, eye symptoms (in the form of redness, watering of eyes, and itching), itching of nose, throat and ear, and any asthma-related symptoms.

Within the scope of study, a total 500 dust samples were collected from the 125 concrete single family homes of 125 patients. From each house, a total four dust samples were collected from the different localities of the house like mattresses (Cotton and Foam) used by patients, floor dust from the bedroom and living room, sofas and carpets used in the homes. All the homes were concrete single family homes without air conditioning. The dust samples were collected from the floor manually with the help of brush. The dust samples were collected from the cotton and foam mattresses, sofas, and carpets by using a 1,200 W vacuum cleaner (Bosch; Munchen, Germany) applied on an area of 1 m² for 2 min. The carpets when present were either made of sisal or jute and area rugs. To prevent mixing of house dusts with each other, the dust samples were collected in zip lock bags. In addition, subtracting hoses and mouthpieces of the vacuum

cleaners were removed and cleaned in every house to prevent any possible contamination.

Each dust sample was labeled indicating collection time, collection site, collection date and was brought to lab for subsequent studies. The temperature and humidity were also noted. The indoor and outdoor temperature and humidity of the houses and temperature and relative humidity of the surface from which dust samples were collected, were measured by using thermo hygrometer.

The mites were isolated from the dust samples within 24 h of collection by floatation method (Fain and Hart 1986). For this, 1 gram of dust was suspended in 80% alcohol for 4–6 h. After 4–6 h, mites started floating on the surface and were isolated. Saturated sodium chloride solution prepared at room temperature was then poured to the petridish containing dust debris to get the remaining mites. By this method, the maximum number of mites was collected as all the dead and live mites floated on the surface. The complete area of the petridish was examined under stereozoom microscope and the mites were collected with the help of fine brush. A minimum 1 and maximum 150 dust mites were collected from the 1 gram of collected dust. The collected dust mites were cleared in 60% lactic acid for 24 h at 37°C temperature. The permanent slides were prepared in Hoyer's medium prepared according to Walter (2001) and were studied under light microscope (Leica xx Switzerland) at 10× and 20× and identified by using the taxonomic keys given by Hughes (1976) and Krantz (1978) and Colloff (2009). The slides are deposited in the Museum of Department of Zoology and Environment Science, Punjabi University, Patiala. Permission to carryout this research work has been taken from Human Ethical Committee of Punjabi University, Patiala wide letter No. 248/DLS/HG. Patients consent was taken from all the patients before conducting the study.

Statistical Analysis

One-way analyses of variance (using SPSS 17.0) were conducted to analyze the relationship of total mite density with three different climatic classes.

The mean number of mites per gram of dust was calculated by dividing the total mites collected from the mite (+) samples to the number of mite (+) samples.

Results

During present study, total 500 dust samples were collected from the homes of 125 patients suffering from AR and AA. Of these, 466 (93.2%) dust samples were found to be positive for dust mites. From the 466 mite positive samples, a total 7,710 mites were isolated. A minimum 1 and maximum 150 mites were found per gram of dust sample (Table 1). Of 7,710 mites, 2,902 (37.63%) mites were found in samples collected during summer season, i.e., CCL-I, 3,728 (48.35%) mites were found in samples collected during rainy season, i.e., CCL-II and only 1,080 (14.01%) mites were found in

Table 1. The incidence of house dust mites in Punjab and number of mites in 1 g of dust

	Number of collected samples		Number of isolated mites	Number of mites in dust samples that weighted 1 g		
	N	%		Minimum	Maximum	Average
Mite (+)	466	93.2	7,710	1	150	16.54
Mite (–)	34	6.8	—			—
Total	500	100	7,710	1	150	16.54

(+) Present.

(–) Absent.

samples collected during winter season, i.e., CCL-III. In this study, the collected mites belonged to order Mesostigmata, suborder Prostigmata, and Oribatida and hypoorder: Astigmata (Zang 2011) Mites belonging to hypoorder Astigmata were the most abundant and frequently found. Of 7,710 mite specimens, 7,404 i.e 96.03% were only from the hypoorder Astigmata, 240 i.e 3.11% from suborder Prostigmata, 46, i.e., 0.60% from order Mesostigmata, and 20, i.e., 0.26% from suborder Oribatida. The identification of the isolated mites belonging to hypoorder Astigmata was performed at the species level. *D. pteronyssinus* (Trouessart 1897) (96.8%), belonging to family Pyroglyphidae was the most common and frequently found mite species followed by *D. farinae* (Hughes 1961) (93.6%), *D. microceras* (Griffiths and Cunnington 1971) (82.4%), *Acarus siro* (Linnaeus 1758) (78.4%), *Tyrophagus putrescentiae* (Schränk 1781) (68.8%), *Lepidoglyphus destructor* (Schränk 1781) (66.4%), *Euroglyphus maynei* (Cooreman 1950) (63.2%), respectively. Mites belonging to the order suborder Prostigmata were identified at the genus level and only one genus *Cheyletus* (48%) from family Cheyletidae was detected, while the identification of the mites belonging to order Mesostigmata (44.8%) and suborder Oribatida (11.2%) remained at the order level (Table 3).

Total 500 dust samples were collected from the homes of 125 patients from these, 466 dust samples were found to be positive for the mites and 44 dust samples were found to be negative for the mites. Of the 500 collected dust samples, 200 dust samples were collected from mattresses, out of these 116 from cotton mattresses and 84 from foam mattresses from which 180 (36.0%) (114 cotton mattresses and 66 foam mattresses) dust samples were found to be positive for the mites, 167 dust samples were collected from bedroom floors out of which 160 (32.0%) dust samples were found to be positive for the mites, 76 dust samples were collected from sofas from which 70 (14.0%) dust samples were found to be positive for the mites and 57 dust samples were collected from the carpets out of which 56 (11.2%) dust samples were found to be positive for the mites (Table 2).

Dominance of mite species

$$D = \frac{100 \cdot \delta}{\Sigma}$$

D: dominance, δ : No. of mites of a given species and Σ : total no. of mites collected from the dust samples (Rajski 1961).

Dominance determines what percentage of the total population (systematic group, life form, linkage, and nutritive chain) belongs to the species. There are five classes of domination:

- Eudominant—above 10%
- Dominant—5.1% to 10%
- Subdominant—2.1% to 5%
- Recedent—1.1% to 2.0%
- Subrecedent—less than 1.1%

Table 2. Different localities of the patient house from which the dust samples were collected

Sites	No. of collected samples	No. of positive samples	% Of positive samples
Mattresses	200	180	36.0
Floor dust	167	160	32.0
Sofas	76	70	14.0
Carpet	57	56	11.2
Total	500	466	

During the present study, it has been observed that *Dermatophagoides pteronyssinus* (Fig. 1a), *Dermatophagoides farinae* (Fig. 1b), *Dermatophagoides microceras* (Fig. 1d), and *Acarus siro* (Fig. 1e) were the eudominant mite species found in the collected dust samples. *Tyrophagus putrescentiae* was a dominant mite species. *Lepidoglyphus destructor*, *Euroglyphus maynei*, and *Cheyletus* (Fig. 1c) were subdominant mite species and the mites from the order Mesostigmata and suborder Oribatida were the subrecedent mites (Table 3).

During present study, it has been observed that *Dermatophagoides pteronyssinus* was found in large number in all three climatic zones, but it was most abundant and frequent in rainy season/climate class II (CCL II), followed by *D. farinae*, *D. microceras*, *Acarus siro*, *Tyrophagus putrescentiae*, *Lepidoglyphus destructor*, *Euroglyphus maynei*, *Cheyletus*, Mesostigmatic, and Oribatida mites which were also most abundant and frequent in rainy season/climate class II (CCL II) as compared to summer season/climate class I (CCL I) and in winter season/climate class III (CCL III) all the above-mentioned mite species and genera were present but were significantly less abundant and frequent (Table 4).

Statistical analysis showed that the seasons had great effect on the all HDMs except *Tyrophagus putrescentiae* which did not depend on the seasons. The analysis showed that *D. pteronyssinus*, *D. farinae*, *D. microceras*, *A. siro*, *L. destructor*, *E. maynei*, and *Cheyletus* were found to be highly significant but on the other hand the Mesostigmatic and Oribatida mites were found to be significant (Table 5).

Discussion

During the study period, 466 of the 500 (93.2%) dust samples collected from 125 houses were found to be mite positive, and a total of 7,710 mite specimens were isolated from the dust samples. Out of these 7,710 mites, 2,902 (37.63%) mites were found in samples collected during summer season, i.e., CCL-I, 3,728 (48.35%) mites were found in samples collected during rainy season, i.e., CCL-II and only 1,080 (14.01%) mites were found in samples collected during winter season, i.e., CCL-III. From the 7,710 isolated mite specimens, 7,404 i.e 96.03% were only from the hypoorder Astigmata, 240 i.e 3.11% from suborder Prostigmata, 46, i.e., 0.60% from order Mesostigmata, and 20, i.e., 0.26% from suborder Oribatida. These studies were in accordance to De Oliveira and Daemon (2003), who reported the prevalence of mites in all the dust samples collected during different seasons. They reported that mite holding rate of houses was 100%. They found 891 mites in winter (22.97%), and 2,988 in summer (77.03%). In winters, they reported that *D. pteronyssinus* was the most prevalent (55.00%) followed by *Blomia tropicalis* (27.06%), *Euroglyphus maynei* (8.85%), and family Cheyletidae (8.07%) and in summer, the most prevalent species was *B. tropicalis* (47.79%), followed by *D. pteronyssinus* (43.38%), Cheyletidae (6.87%), and *E. maynei* (1.28%). In our study, maximum number of mites were found in rainy season/climate class II (CCL II) but *D. pteronyssinus* was most abundant and frequent in all three seasons. Similarly, Podder et al. (2008) made a faunistic survey on the prevalence of total mites and four common allergenic mites in the city of Kolkata (India) for two consecutive years. They collected bed and bedroom floor dust separately from homes inhabited by asthmatic patients situated in different corners of the city on monthly basis from January 2004 to December 2005. They noted that the population levels of total mites and four common allergenic mites, namely *Dermatophagoides pteronyssinus*, *D. farinae*, *Austroglyphus geniculatus*, and *Blomia tropicalis* separately, were highest during

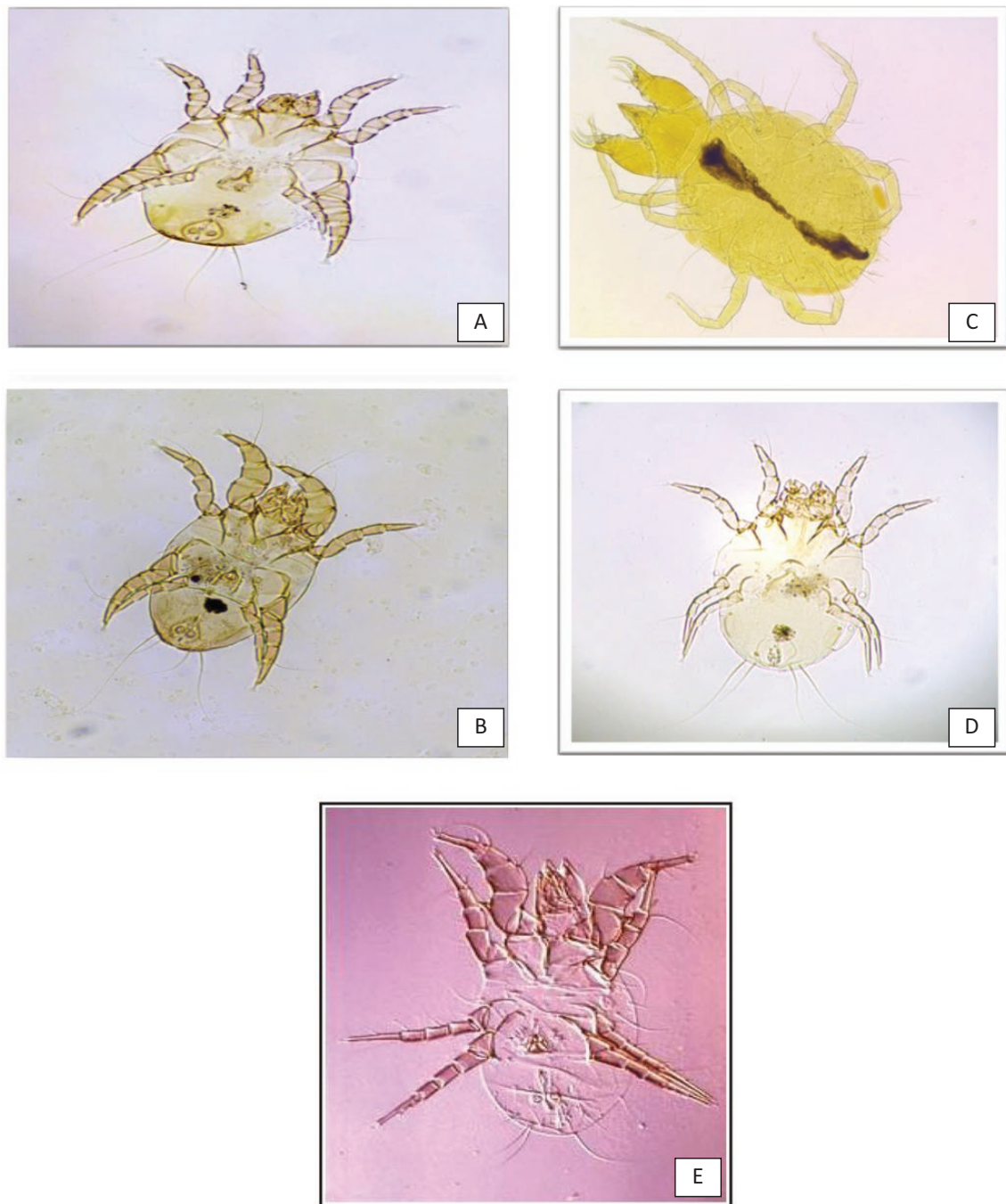


Fig. 1. (a) *Dermatophagoids pteronyssinus* (Trouessart, 1897); (b) *Dermatophagoides farinae* (Hughes, 1961); (c) *Cheyletus* (Latreille, 1796); (d) *Dermatophagoides microceras* (Griffiths & Cunnington, 1971); (e) *Acarus siro* (Linnaeus, 1758).

the premonsoon period (March to May), whereas densities were low in all cases during winter (December to February). Further, they suggested that the season had the most significant effect on the relative abundance of HDMs except *Dermatophagoides farinae* which was present in all the samples throughout the study period. During present study, *Dermatophagoides pteronyssinus* was found in all the dust samples throughout the year but it was most abundant and frequent in rainy season/climate class II (CCL II). *D. farinae*, *D. microceras*, *Acarus siro*, *Tyrophagus putrescentiae*, *Lepidoglyphus destructor*, *Euroglyphus maynei*, *Cheyletus*, Mesostigmatic, and Orbatida mites were also abundant and frequent in rainy season/climate class II (CCL II), followed by summer season/climate class I (CCL I) and

in winter season/climate class III (CCL III) all the above-mentioned mite species and genera were present but were significantly less abundant and frequent. Jogdand and Ingole (2013) determined that the different environmental parameters like temperature, relative humidity, and rainfall play determinant role in increasing mite population. During the rainy season, moderate temperature ($25^{\circ}\text{C} + 2$ or -2°C), high relative humidity (80–90%), and frequent rainfall increase the mite population. Whereas in summer season, maximum temperature (35°C to 45°C), low relative humidity, and rainless days decrease the mite population because they die during hot conditions and in the winter season, low temperature (below 15°C or less), less relative humidity (40% or less), and rainless days also decrease the

Table 3. Incidence and dominance of house dust mites in Punjab from March 2015 to February 2016

Mites	No. of houses (125)	Incidence in houses (%)	Number of isolated mites	Dominance
<i>Dermatophagoides pteronyssinus</i>	121	96.8	1,820	Eudominant
<i>Dermatophagoides farina</i>	117	93.6	1,600	Eudominant
<i>Dermatophagoides microceras</i>	103	82.4	1,530	Eudominant
<i>Acarus siro</i>	98	78.4	1,244	Eudominant
<i>Tyrophagus putrescentiae</i>	86	68.8	694	Dominant
<i>Lepidoglyphus destructor</i>	83	66.4	274	Subdominant
<i>Euroglyphus maynei</i>	79	63.2	242	Subdominant
<i>Cheyletus</i>	60	48	240	Subdominant
Mesostigmata	56	44.8	46	Subrecent
Orbatida	14	11.2	20	Subrecent
Total			7,710	

Table 4. Showing the seasonal variations in prevalence (% age) of mite fauna during CCLI, CCLII, and CCLIII

Season/mites	Summer season CCL I	Rainy season CCL II	Winter season CCL III	Total no. of mites
	N = 2,902	N = 3,728	N = 1,080	N = 7,710
	n = 156	n = 216	n = 94	n = 466
	AT = 32.3°C	AT = 28.65°C	AT = 17.0°C	
	AH = 58.7%	AH = 87.4%	AH = 54.65%	
<i>Dermatophagoides pteronyssinus</i>	694 (23.92%)	920 (24.68%)	206 (19.07%)	1,820 (23.61%)
<i>Dermatophagoides farina</i>	686 (23.63%)	714 (19.15%)	200 (18.52%)	1,600 (20.75%)
<i>Dermatophagoides microceras</i>	554 (19.09%)	778 (20.87%)	198 (18.33%)	1,530 (19.84%)
<i>Acarus siro</i>	474 (16.33%)	576 (15.45%)	194 (17.96%)	1,244 (16.13%)
<i>Tyrophagus putrescentiae</i>	216 (7.44%)	334 (8.96%)	144 (13.33%)	694 (9.00%)
<i>Lepidoglyphus destructor</i>	90 (3.10%)	134 (3.59%)	50 (4.63%)	274 (3.55%)
<i>Euroglyphus maynei</i>	86 (2.96%)	118 (3.17%)	38 (3.52%)	242 (3.14%)
<i>Cheyletus</i>	80 (2.76%)	120 (3.22%)	40 (3.70%)	240 (3.11%)
Mesostigmata	16 (0.55%)	22 (0.59%)	8 (0.74%)	46 (0.60%)
Orbatida	6 (0.21%)	12 (0.32%)	2 (0.19%)	20 (0.26%)

N = Number of mites; n = Number of samples positive for mites; AH = average humidity of the season; AT = average temperature of the season.

Table 5. Showing the one-way ANOVA test for relationship of different seasons and the mite density

Name of mites	Seasons	Sum of squares	Mean square	F value	Remarks
<i>Dermatophagoides pteronyssinus</i>	Between seasons	353.5	2	40.69	$P < 0.0001$
	Within seasons	1,342	309		
<i>Dermatophagoides farinae</i>	Between seasons	338	2	52.65	$P < 0.0001$
	Within seasons	991.9	309		
<i>Dermatophagoides microceras</i>	Between seasons	147.6	2	33.99	$P < 0.0001$
	Within seasons	671	309		
<i>Acarus siro</i>	Between seasons	75.74	2	32.02	$P < 0.0001$
	Within seasons	365.5	309		
<i>Tyrophagus putrescentiae</i>	Between seasons	3.463	2	2.838	NS ($P = 0.0601$)
	Within seasons	188.5	309		
<i>Lepidoglyphus destructor</i>	Between seasons	51.25	2	24.93	$P < 0.0001$
	Within seasons	317.6	309		
<i>Euroglyphus maynei</i>	Between seasons	59	2	30.05	$P < 0.0001$
	Within seasons	303.3	309		
<i>Cheyletus</i>	Between seasons	62.74	2	34.78	$P < 0.0001$
	Within seasons	278.6	309		
Mesostigmata	Between seasons	1.933	2	6.314	$P < 0.05$
	Within seasons	47.29	309		
Orbatida	Between seasons	0.8638	2	6.107	$P < 0.05$
	Within seasons	21.85	309		

^aSignificant at $P < 0.05$, ^{NS}Nonsignificant at $P > 0.05$.

Table 6. Showing the mean and standard deviation of mite density in three different climatic classes

Name of mites	Seasons	Mean	Standard deviation
<i>Dermatophagoides pteronyssinus</i>	CCL-I	4.61	2.57
	CCL-II	4.29	2.06
	CCL-III	2.19	1.01
<i>Dermatophagoides farinae</i>	CCL-I	4.56	2.32
	CCL-II	3.32	1.49
	CCL-III	2.13	0.88
<i>Dermatophagoides microceras</i>	CCL-I	3.61	1.68
	CCL-II	3.59	1.65
	CCL-III	2.11	0.85
<i>Acarus siro</i>	CCL-I	3.14	1.10
	CCL-II	3.13	1.25
	CCL-III	2.06	0.90
<i>Tyrophagus putrescentiae</i>	CCL-I	1.39	0.77
	CCL-II	1.64	1.01
	CCL-III	1.53	0.54
<i>Lepidoglyphus destructor</i>	CCL-I	0.54	0.91
	CCL-II	1.47	1.36
	CCL-III	0.53	0.80
<i>Euroglyphus maynei</i>	CCL-I	0.61	0.98
	CCL-II	1.51	1.19
	CCL-III	0.40	0.81
<i>Cheyletus</i>	CCL-I	0.57	0.98
	CCL-II	1.54	1.12
	CCL-III	0.43	0.73
Mesostigmata	CCL-I	0.11	0.32
	CCL-II	0.28	0.58
	CCL-III	0.09	0.28
Orbatida	CCL-I	0.04	0.20
	CCL-II	0.15	0.43
	CCL-III	0.02	0.15

mite population because the mite perish due to chilling. Similarly during present study mite species were significantly more prevalent in rainy season, i.e., CCL II with moderate temperature (28.65°C) and high relative humidity (87.4%) followed by summer season, i.e., CCL I with high temperature (32.3°C) and low relative humidity (58.7%) but in winter season, i.e., CCL III low temperature (17°C) and low humidity (54.65%) will significantly decrease the mite population level.

Conclusion

The number of mites per gram of dust was found to be 16.54. The most common species was *D. pteronyssinus* which was followed by *D. farinae*, *D. microceras*, *Acarus siro*, *Tyrophagus putrescentiae*, *Lepidoglyphus destructor*, *Euroglyphus maynei*, *Cheyletus*, Mesostigmatic, and Orbatida mites.

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