Zoosymposia 6: 170–179 (2011)
www.mapress.com/zoosymposia/

ISSN 1178-9905 (print edition)
ZOOSYMPOSIA
ISSN 1178-9913 (online edition)

Emerging scenario of important mite pests in north India*

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* *In*: Moraes, G.J. de & Proctor, H. (eds) Acarology XIII: Proceedings of the International Congress. Zoosymposia, 6, 1–304.

Abstract

The results generated by the Multi Locational Project on Agricultural Acarology, All India Coordinated Project on Agricultural Acarology, Network Project on Agricultural Acarology and the Network Project on Insect Biosystematics since 1983 are described, highlighting the most important mite pests of north India. The following species are considered major pests in that region: Tetranychidae - *Eutetranychus orientalis* (Klein), *Oligonychus coffeae* (Nietner), *Tetranychus ludeni* Zacher, *Tetranychus neocaledonicus* André and *Tetranychus urticae* Koch; Eriophyidae - *Aceria litchii* (Keifer) and *Aceria mangiferae* (Sayed); Tarsonemidae - *Polyphagotarsonemus latus* (Banks). Other 16 species in those families as well as in the Tenuipalpidae are also considered important as plant pests in this area of India. Among the tetranychids, *T. ludeni* was identified as an alarming problem in 1987. Many outbreaks of this pest were recorded from 1988 to 1990 on cowpea [*Vigna unguiculata* (L.) Walp], an important summer vegetable of eastern Uttar Pradesh. Okra (*Abelmoschus esculentus* Moench) and eggplant (*Solanum melongena* L.), particularly when grown in the summer, have serious problems with *T. urticae* and *Tetranychus macfarlanei* Baker & Pritchard. *Panonychus ulmi* (Koch) has emerged as a serious problem on the expanding cultivation of apple in Himachal Pradesh, whereas *Petrobia latens* (Muller) populations are increasing in dryland cultivation of Rajasthan, attaining serious pest status mainly on wheat and coriander. Among the tarsonemids, a serious increase in *P. latus* on chilli has coincided with the growing cultivation of this crop, whereas increasing population levels of *Steneotarsonemus spinki* Smiley have caused severe damage to rice since its recent discovery in northern India. Serious problems have also been caused to tomato by the eriophyid *Aceria lycopersici* (Wolf) and to ber (*Ziziphus mauritiana* Lam.) by the tenuipalpid *Larvacarus transitans* (Ewing), an emerging serious pest of in Rajasthan area. The reason attributed to the increasing mite infestations is the widespread and continuous use of synthetic pyrethroid pesticides, which negatively affect the predatory mite fauna. The paper focuses on problems of mite outbreak and suggests future thrust for use of predatory mites as bio-agents for integrated mite control.

Key words: Eriophyidae, pest management, Tarsonemidae, Tenuipalpidae, Tetranychidae.

Introduction

Before the 1980s, farmers of eastern Uttar Pradesh were not aware of infestations by plant-feeding mites. Infestations of cowpea [*Vigna unguiculata* (L.) Walp], which is an important vegetable crop in India, by *Tetranychus ludeni* Zacher was first observed by farmers of eastern Uttar Pradesh in the early 1980´s, after Singh (1976) first reported about that emerging pest problem. However, information about mites was available in the peninsular part of the country (ChannaBasavanna, 1981; Prasad, 1982). Nassar & Ghai (1981), realizing the importance of phytophagous mites, described the taxonomic status of tetranychoid mites infesting vegetable and fruit crops in the Delhi area. The abundance of *T. ludeni* started to increase around the same time in other parts of north India, attracting the attention of the Indian Council of Agricultural Research (ICAR).

Since then, not much has been published concerning the progression of problems caused by mites, although it is a fact that farmers have been using progressively larger amounts of insecticide mixtures of monocrotophos, endosulfan, and synthetic pyrethroids for the control of different insect species, provoking outbreaks of tetranychid mites. In order to monitor mite problems in India, ICAR launched in 1983 a Multi Locational Research Project in the field of Agricultural Acarology, involving the participation of eight centers located in different parts of the country. The contribution of Gupta (1985) was of major importance to understand the mites of agricultural interest in the country. Problems caused by

 Accepted by G. J. de Moraes: 30 Jul. 2011; Published: 20 Dec. 2011

mites continued to increase, and ICAR emphasized the study of these organisms by initiating a project named "All India Coordinated Project on Agricultural Acarology" in 1987. The project was later expanded and renamed "All India Network Project on Agricultural Acarology", involving nine centers covering the whole country. Researches through ICAR network projects created infrastructure and manpower to take up national problems of mite infestations. In 1989, the mite problem had become so alarming on cowpea in some areas of Uttar Pradesh that print media became involved in the publication of information on mite infestations to the general public. Gupta (1991) further described the mites of agricultural importance in India, giving details of their economic status. Reviews about agricultural acarology in India were provided by Singh *et al*. (2000) and Singh (2004).

Much emphasis has been placed in recent years on the correct identification of plant mites and the symptoms they cause. However, limited effort has been dedicated to determine their actual damage, which remains a real need for the adoption of more appropriate control measures. Broad-spectrum pesticides often adversely affect predatory mites commonly associated with the phytophagous mites, leading to outbreaks of the latter. Therefore, the present paper aims to provide an overview of the phytophagous mite species associated with various important crops in northern India and the symptoms they cause to host plants.

Materials and Methods

Information on mite infestation in northern India were obtained in regular surveys of the Multi Locational Project on Agricultural Acarology, followed by the All India Coordinated Project on Agricultural Acarology and the Network Project on Agricultural Acarology, since 1983. More recent data were obtained under the Network Project on Insect Biosystematics. The surveys were conducted in Uttar Pradesh, Uttarakhand, Bihar, Jharkhand and Madhya Pradesh, on different crops. Sampling was done as described by Poe (1980) for soybean. Leaves were collected weekly from different parts of the canopy of each plant species.

The presence of mites on plant structures was determined with the use of hand lenses (10 x), and by taking into consideration typical symptoms of infestation by mites. The infested structures were brought to the laboratory, where mites were observed under a stereomicroscope. Mites were handled with camel hair brushes and dissecting needles, and mounted in Hoyer´s medium for identification. Whenever necessary, mounted mites were sent to experts for confirmation of the identification.

Results and Discussion

The 24 mite species considered to be of most importance in northern India are listed in Table 1, with their pest status on the major listed crops on which they have been found. Of these, eight species are considered major pests, nine important pests and seven minor pests on different crops, according to the usual intensity of infestation.

Relevant information about the mites mentioned in Table 1 is subsequently provided.

1. Tetranychidae

This family was mentioned by Migeon & Dorkeld (2006) to be comprised of about 1,250 species. Many tetranychids are actual and potential pests in India (Singh & Mukherjee, 1989; Gupta, 1991). Their feeding activity reduces chlorophyll content and leads to formation of numerous empty cells at a site, in which is followed by the formation of yellow or brown specks or stipples in the attacked spot. Severely attacked leaves shrivel, die and eventually drop off the plant.

TABLE 1. Mite pests of north India.

Family/Mite species	Major host plants	Pest Status[1]
Tetranychidae		
Eotetranychus hirsti Pritchard & Baker (Fig spider mite)	Fig	+
Eutetranychus orientalis (Klein) (Oriental red mite/Citrus brown mite)	Apple, ber, citrus, cotton and cucurbits	+++
Oligonychus coffeae (Nietner) (Red tea mite)	Coffee, mango and tea	+++
Oligonychus indicus (Hirst) (Sugarcane red spider mite)	Sorghum and sugarcane	++
Oligonychus mangiferus (Rahman & Sapra) (Mango red spider mite)	Mango	++
Panonychus ulmi (Koch) (European red mite)	Apple	++
Petrobia latens (Muller) (Brown wheat mite)	Barley, coriander and wheat	++
Schizotetranychus andropogoni (Hirst) (White patchy/sugarcane leaf spotted mite/ web mite)	Cereals and sugarcane	++
Tetranychus ludeni Zacher (Red-legged spider mite/Bean spider mite)	Beans and vegetables	+++
Tetranychus macfarlanei Baker & Pritchard (Spider mite)	Cucurbits	+
Tetranychus neocaledonicus André (Red vegetable mite)	Fig, mango, ornamental plants and vegetables	+++
Tetranychus urticae Koch (Two spotted spider mite) [=*Tetranychus cinnabarinus* (Boisd.)]	Bean, brinjal, cotton, cucurbits and okra	+++
Tenuipalpidae		
Brevipalpus californicus (Banks) (Citrus flat mite)	Citrus and tea	+
Brevipalpus phoenicis (Geijskes) (Scarlet mite/Reddish black flat mite/ Leprosis mite)	Citrus, guava and papaya	+
Dolichotetranychus floridanus (Banks) (Pineapple flat mite)	Pineapple	+
Larvacarus transitans (Ewing) (Ber gall mite)	Ber	+
Eriophyidae		
Aceria cajani ChannaBasavanna (Pigeonpea sterility mosaic mite)	Pigeonpea	++
Aceria guerreronis (Keifer) (Coconut mite)	Coconut	++
Aceria litchii (Keifer) (Litchi erineum mite)	Litchi	+++
Aceria lycopersici (Wolff.) (Tomato/Brinjal erineum mite)	Brinjal and tomato	++
Aceria mangiferae (Sayed) (Mango bud mite)	Mango	+++
Eriophyes cernuus Massee (Jujube gall mite, Ber gall mite)	Ber	++
Tarsonemidae		
Polyphagotarsonemus latus (Banks) (Citrus silver mite/yellow mite/ broad mite)	Beans, chilli, jute and potato	+++
Steneotarsonemus spinki Smiley (Rice sheath mite)	Rice	+

[1] +++: Major Pest; ++: important pest; +: Minor pest

***Eotetranychus hirsti* Pritchard & Baker**

It is an alarming pest of fig in Delhi, Punjab, West Bengal and Uttar Pradesh. This mite is host specific, hence known as fig spider mite. It is greenish yellow with black blotches all over the dorsum. Infested leaves drop prematurely, often resulting in complete plant defoliation. Fruits may also drop.

***Eutetranychus orientalis* (Klein)**

This is a major pest of citrus and sometimes reported from pear, peach, ber, cucurbits and cotton, damaging the upper surface of fully grown leaves. Population of this mite increases on apple from March to June (Mukherjee & Singh, 1993; Singh *et al*., 2000). It has been collected on papaya, in the Varanasi region, in the eastern part of Uttar Pradesh. Infestations start along the midrib, with mites moving farther away as population size increases. The webbing produced by the mites traps dust particles, giving the upper leaf surface a dirty appearance.

***Oligonychus coffeae* (Nietner)**

This is one of the serious pests of tea, coffee and mango in northern India. It is the most alarming pest of tea in the northeastern region of the country. It normally feeds on the upper surface of old leaves, but in case of severe infestation in the summer, the lower surface and the young leaves are also infested. The mites live under the webbing they produce and are found throughout the year. They have two population peaks a year, the first between March and May and the other in September–October. Banerjee & Cranham (1985) reported that *O. coffeae* reached outbreak level more commonly in northern than in southern India and Sri Lanka.

***Oligonychus indicus* (Hirst)**

Feeding of this mite causes the appearance of reddish spots on sorghum and sugarcane, which increase with severity of attack. These spots later coalesce to form large red patches, which eventually may cover the whole leaf.

***Oligonychus mangiferus* (Rahman & Sapra)**

This is an important pest of mango in different mango growing regions of eastern Uttar Pradesh. It infests the upper leaf surface.

***Panonychus ulmi* (Koch)**

Adults of this species are easily recognized in the field by their brick red colour. This mite has been collected in most of apple orchards of Himachal Pradesh, reducing plant growth and fruit quality. Bharadwaj & Bharadwaj (2005) reported high levels of this mite on apple in Himachal Pradesh. Its infestation is so high that Indian Council of Agricultural Research has established a centre at Masobra to tackle the problem of *P. ulmi* in the region.

***Petrobia latens* (Muller)**

This is a serious pest in dryland agriculture, reaching usually higher densities on wheat than on barley. Coriander was also found infested by this species. Population levels are highest in March. It is most common under rainwater-fed cultivation. Sharma & Srinivasa (2004) published a comprehensive report about this species.

***Schizotetranychus andropogoni* (Hirst)**

This is a very detrimental pest of sugarcane in the northern part of the country, causing the formation of white blotches on the leaf, which gradually dry out. The webbing it produces turns brown and at a later stage it is blown off by wind, dispersing the mites.

***Tetranychus ludeni* Zacher**

This mite has been identified as very damaging to cowpea in the Varanasi region (Singh & Mukherjee, 1989). It is also a major pest of vegetable in the summer (May to June). Many farmers have given up the cultivation of these crops because of the susceptibility of the existing varieties. Attacked cowpea leaves initially present yellow patches, which eventually become necrotic. Aggregation of mites on tips of the pods is common during periods of the day when temperature is above 38°C. It is widespread in the warmer parts of the world and occurs on a great variety of cultivated and wild plants. During our surveys, high populations were recorded in April, May and June. This mite always prefers the lower leaf surface. At high population levels, copious webbing covers the entire plant, leading the mites to migrate.

***Tetranychus macfarlanei* Baker & Pritchard**

It builds up small colonies on the lower leaf surface. Infestations are higher on mature than on young crops (Singh *et al*., 2000).

***Tetranychus neocaledonicus* André**

This mite is a serious pest on brinjal and it was reported from sponge gourd, bitter gourd, beans, tomato and potato. It was also recorded throughout the year on fig and mango trees (Singh *et al*., 2000).

***Tetranychus urticae* Koch**

This is an alarming pest on different crops in the northern states of India. The population starts to develop in late February and to decline in July, when monsoon rains start (Singh & Singh, 1993). It also produces abundant webbing when populations are too high, when mites then start to disperse (Singh *et al*., 2000).

2. Tenuipalpidae

Baker & Tuttle (1987) reported that mites of this group, called flat mites or false spider mites, are widely distributed and more numerous in warmer zones. In total 891 tenuipalpid species belonging to 34 genera have been reported worldwide (Mesa *et al*., 2009). Childers *et al*. (2003) described the importance of *Brevipalpus californicus* and *B. phoenicis* in different areas of the world. These mites are similar to spider mites, but do not spin silken webs. Several false spider mites are of great economic importance, infesting mainly fruit trees. However, very little work has been done on these mites in India (Gupta, 1985). They are flat, pear shaped, mostly reddish or greenish, ranging from 0.3 to 0.35 mm in length, slow moving and normally found on the undersurface of the leaves, on twigs and on fruits. Some specialized members of this family form plant galls, within which they feed. In India, the genera *Brevipalpus* and *Tenuipalpus* are of major concern.

***Brevipalpus californicus* (Banks)**

This mite has been collected on citrus and papaya from different northern states of India. It is the best known species of flat mite and has long been known as a citrus pest. Adult mites feed on the lower leaf surface, mostly along the mid-rib. Feeding causes yellow spots that later coalesce to form brown patches. In case of heavy infestation, the mites congregate at the base of fruits and their feeding may result in premature fruit drop.

***Brevipalpus phoenicis* (Geijskes)**

This is a polyphagous mite species. These mites are usually aggregated along the leaf midrib. Infested leaves turn pale yellow and develop brownish patches, dropping off prematurely. Attacked guava fruits show brownish patches. Chandra & ChannaBasavanna (1974) described the importance

of guava scarlet mite. Although extremely rare, males of this species were also collected on guava plants.

***Dolichotetranychus floridanus* (Banks)**

This mite attacks plants of all ages, but causes greater damage to young plants. It feeds on the soft white tissue at the base of the leaf. They produce rust-like spots that can be infected by bacteria and fungi, so that rotting of the infected tissues may occur. Severely infested plants may remain small, bearing no fruits.

***Larvacarus transitans* (Ewing)**

During our surveys in Rajasthan State, this mite was collected in blisters of ber plants, *Ziziphus mauritiana* Lam. (Fig. 1). The twigs of bushy ber cultivars were found heavily infested by this mite. On the average, 20 to 80% of the bushes were infested. A report on this mite and its importance has been given by Singh *et al*. (1996). Distinctive characters of this mite are the presence of three pairs of legs in both nymphal and adult males and females (Fig. 1C, D). Ber bushes were once believed to be free from insect and diseases, but in the survey conducted in 1996, alarming problems caused by this mite were recorded, including the presence of blisters all around tender twigs (Fig. 1B). The galls rupture during monsoon. After emerging from the galls, the mites hide themselves in cracks and crevices of tree trunk, starting new infestations. The intensity of gall formation was higher on local than on improved cultivars. Twigs bearing galls bore less fruits than healthy twigs.

3. Eriophyidae

These are very tiny mites, usually known as gall, rust, bud, blister or erineum mites, according to the type of damage they cause. The galls may be leaf galls or bud galls. They can also cause leaf

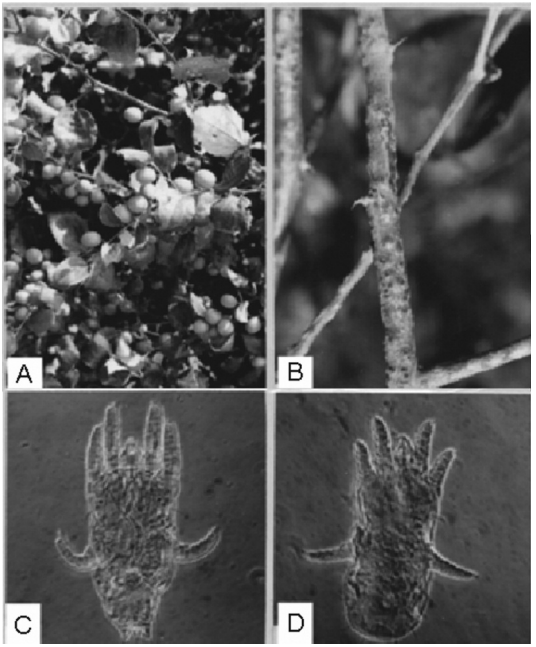

FIGURE 1. Healthy (A) and infested (B) twigs of *Ziziphus mauritiana*; adult male (C) and adult female (D) of *Larvacarus transitans*.

folding and twist blisters. They cause yield reduction in various crops. Six types of plant injuries were recorded in our surveys, i.e. big buds, curling/crinkling and shrinking of leaves, discolouration, erineum, russeting and galls. Apart from causing direct injuries, mites of this group are vectors of plant viruses, as those causing pigeonpea sterility mosaic, fig mosaic, wheat streak and sugarcane streak. Amrine *et al*. (2003) reported 3,442 valid species of Eriophyoidea in 301 genera worldwide, the vast majority of the species belonging to the Eriophyidae.

***Aceria cajani* ChannaBasavanna**

In eastern Uttar Pradesh, sterility mosaic is a serious disease of pigeonpea, which is an important source of protein in vegetarian diets. The virus causing this disease is vectored by *A. cajani*. In our surveys, this mite was recorded in August and September at low population levels and in March at high levels, when the crop is about to mature. The symptoms include general stunting and yellowing of infected plants, proliferation of branches, leaf mosaic mottle, reduction in leaflet size and partial or complete plant sterility. The importance of this mite and of the associated disease was reported by Srinivasa *et al*. (2004).

***Aceria guerreronis* (Keifer)**

This mite was first noticed in coastal states of south India in 1998. The sudden problem posed by it has jeopardized the cultivation of coconut in Tamil Nadu and Kerala States, in that part of India. The appeal made by coconut growers attracted the attention of Indian Parliament and Indian Council of Agricultural Research. In our surveys, this mite was recorded from the coastal districts of West Bengal. It causes premature dropping of young nuts, imparting discoloration or scars on their surfaces, taking shelter beneath the floral bracts. The injury begins around the floral bracts and extends down to the inner husks or fibres of coconut. The injured area becomes shriveled brown and scattered. A comprehensive study on this mite has been done by Kannaiyan *et al*. (2002).

***Aceria litchii* (Keifer)**

This mite has jeopardized the cultivation of litchi (*Litchi chinensis*), a cash crop grown extensively in Muzaffarpur area of Bihar State, by causing erineum on the underside of leaves. In the beginning of the attack, the leaves look greener than normal, later turning light to deep brown with velvety hair growth. The deep brown colour indicates that the erineum is drying and that the mites are abandoning it to move to other leaves. The affected leaves become distorted or curled and eventually dry and fall off.

***Aceria lycopersici* (Wolff)**

High levels of this mite are observed on brinjal and tomato in the summer. The first sign of damage are the curling of the lower leaves and appearance of a silver gloss on the lower leaf surface; later, infested leaves become bronze coloured, withering and eventually dying. Before damage is noticeable on the top most leaves, their lowermost portion loses the surface hairs. The mites also feed on the stem, whose color changes from green to brown, cracks appearing on the surface.

***Aceria mangiferae* Sayed**

Mango malformation is a serious malady of mango in north India. This problem has been related to this mite and to a fungus. Both vegetative and floral malformations can occur, the former being most common on seedlings. However, yield reduction is caused mainly by floral malformations, because of the formation of dense masses of flower buds and the consequent reduced fruit set.

***Eriophyes cernuus* Massee**

This mite causes woody galls usually on one side of the stem of jujube plants. In jujube orchards at Varanasi, plants often suffer with heavy and bulky galls distributed over the tree. Galls are small

on younger trees but may be large in older trees. We have recorded galls of 2 to 3 kg. Thousands of mites can be collected by rupturing a small portion of a gall.

4. Tarsonemidae

This family was reported by Lin & Zhang (2002) to be comprised of about 530 species. These are very small mites, with sclerotized and shiny integument. The body and posterior legs are sparsely set with setae. Plant inhabiting species are mostly found on the undersurface of young leaves. Males often carry female deutonymphs.

***Polyphagotarsonemus latus* (Banks)**

Chilli has emerged as one of the cash crops in eastern Uttar Pradesh. The cultivation of this crop in progressively larger scale has coincided with increasing infestation levels of this mite and with increasing crop losses. The damage shows up as bronzed and distorted new growth, with curled leaf margins. Leaf hairs become prominent, the lower surface of the leaves turn reddish and the plant becomes russetted. Starting at the tip, the plant withers and auxiliary buds then produced are killed (Tambera disease). Similar effects are produced on red pepper plants; early infestation prevents flower and fruit development, while later infestations cause flower drop (Murda disease). In the 1980´s, the broad mite was causing severe losses to chilly growers, because of the use of inadequate products for its control. However, the use of adequate products has greatly reduced losses, and the cultivation of this cash crop has expanded.

***Steneotarsonemus spinki* Smiley**

The rice sheath mite, *S. spinki*, has been found infesting rice plants in eastern Uttar Pradesh, where some varieties were found to be very susceptible to it. Karmakar (2008) observed it as a serious rice pest for the first time in West Bengal. Infested leaf sheath turn brown, whereas infested panicles produce chaffy or discolored grains. In recent years, rice sheath mite is gaining a serious pest status in the rice growing areas of Uttar Pradesh, especially on fine rice varieties.

Monitoring mites is an important component of an integrated control program. Checking crops weekly and taking leaf samples is essential to identify and determine pest and predator activity in a crop ecosystem. When hazardous chemicals are used, careful monitoring is required periodically to check whether pest resurgence or predatory mite decline has occurred.

The expanding agriculture in India requires more input in mite research, especially studies on biodiversity, determination of economic injury levels and economic thresholds and exploration of bio-agents for integrated mite control. So far, predatory mites are unexploited in India on large scale basis and there is scope to utilize phytoseiid predators for control of different plant pests, especially the two spotted spider mite. Gupta (2010) reported a total of 1,700 mite species from different parts of India, 998 of which were phytophagous, whereas Singh & Raghuraman (2010) reported the total number of estimated species, including phytophagous mites, to be 2,670. Fig. 2 shows that faunistic study on mites progressed steadily in India after the first half of the last century. The number of reported species jumped from 35 in 1950´s to 2,350 in the year 2000 and to an estimated 2,670 species in 2010. The recorded major groups of plant feeding mites are spider mites (Tetranychidae: about 106 species), false spider mites (Tenuipalpidae: about 98 species), gall or bud mites (Eriophyidae: about 485 species) and yellow or broad mites (Tarsonemidae: about 10 species). Associated with those mites, more than 320 predatory mites are reported from India. Most of the phytophagous mites reported from India remains under effective control, probably by the action of natural enemies, and those should be preserved.

Mass multiplication techniques are to be standardized for the success of biocontrol programs. The expanding growth of enclosed poly houses and glass houses for cultivation of flowers and ve-

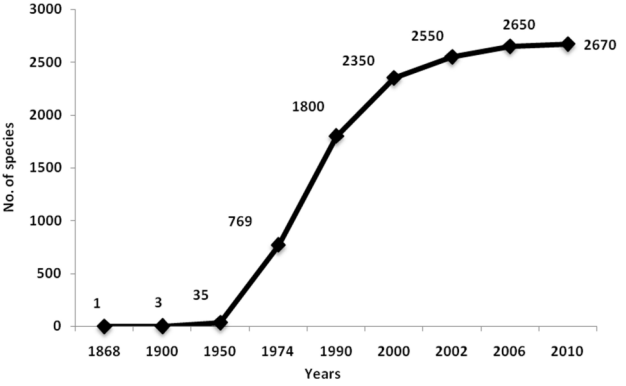

FIGURE 2. Total numbers of mite species reported from India since 1868 (from Singh & Raghuraman, 2010)

getables is also attracting the attention of acarologists for identification of emerging mite problems as well as their management through predatory mites. For an integrated control standpoint, more emphasis is required on the determination of eco-friendly acaracides. Outbreak of plant feeding mites is common in many areas and farmers need to be aware of those organisms and be training to use acaricides in judicious way, avoiding the use of products which are inadequate because of the inefficiency against the pest to be controlled or because of their undesirable environmental effect, including effects on growers and consumers. Studies on pesticide resistance are also required for proper crop care to meet vegetable and food requirement of the growing population of the country.

Acknowledgements

The financial support given by Indian Council of Agricultural Research, New Delhi, is highly acknowledged. We are thankful to Dr. Masoud Arbabi for the photographs shown in this paper. The authors wish to thank Dr. S.K. Gupta, Zoological Survey of India, Kolkata for taxonomical support in the identification of mites.

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