

# Widespread infestation of the exotic mealybug species, *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae), on cotton in India

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## Abstract

A survey was conducted in 47 locations in nine cotton-growing states of India to identify the composition of mealybug species occurring on cotton. Results of the taxonomic study showed that two mealybug species, the solenopsis mealybug, *Phenacoccus solenopsis* (Tinsley), and the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green), were found to infest cotton plants from all nine cotton growing states of the country. However, *P. solenopsis* was found to be the predominant mealybug species, comprising 95% of the samples examined. *P. solenopsis*, which was hitherto not reported to occur in India, now appears to be widespread on cotton in almost all cotton-growing states of the country. *P. solenopsis* is an exotic species originated from the USA and was reported to damage cotton and crops of 14 families. This report discusses the implications of the introduction of this exotic polyphagous pest species and the necessary steps to mitigate its potential threat to agriculture in India.

**Keywords:** cotton, *Gossypium hirsutum*, mealybug, *Phenacoccus solenopsis*

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## Introduction

Mealybugs (Hemiptera: Pseudococcidae) are small sap-sucking insects, and some pest species cause severe economic damage to a wide range of vegetable, horticultural and field crops. Infested plants can show general symptoms of distorted and bushy shoots, crinkled and/or twisted and bunchy leaves, and stunted plants that dry completely in severe cases. Historically, mealybugs were never considered as major pests of economic significance on cotton in India

(APCoAB, 2006). Isolated reports indicated the occurrence of the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green), on the native 'desi' species, *Gossypium arboreum* (Linn.), in Punjab (Dhawan *et al.*, 1980) and on the new world cotton, *Gossypium herbaceum* (Linn.), in Gujarat (Muralidharan & Badaya, 2000). However, there is no published evidence of the occurrence of mealybugs on *Gossypium hirsutum* (Linn.) in India, which currently occupies more than 80% of the 23.7 million acres of cotton cultivated in the country. The mealybug *M. hirsutus* was first observed in traces on *G. hirsutum* sporadically in parts of central Gujarat (Baroda and Bharuch districts) initially in 2000 (Jhala & Bharpoda, 2008). Thereafter, during 2006, mealybugs caused economic damage, reducing yields up to 40–50% in affected fields in several parts of Gujarat. Mealybug infestation was also recorded

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(Dharajyoti *et al.*, 2008) in 2006 on *G. hirsutum* in all the nine cotton-growing states of India, Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka. Severe economic damage to *G. hirsutum* was reported in 2007 (Dharajyoti *et al.*, 2008; Dhawan, 2008) in four major cotton-growing districts (Bathinda, Muktsar, Faridkot and Ferozepur) of Punjab, two districts (Hisar and Sirsa) of Haryana, and low to moderate damage in parts of Maharashtra, Tamil Nadu and Andhra Pradesh. According to Goswami (2007), nearly 2000 acres of cotton crop were destroyed by the mealybug by mid-July and over 100 acres of mealybug-infested Bt cotton was uprooted in Raikot-Kalan village in Bathinda. By the end of the Kharif season (June–October), the total damage in 2007 was estimated to range from US\$400,000 to 500,000 in north India alone.

A recent report (Muhammad, 2007) published by the Centre for Agro-Informatics Research (CAIR), Pakistan, states that the mealybug had destroyed 0.2 million bales (170 kg lint per bale) and 150,000 acres (out of the 8.0 million acres) of cotton area all across Pakistan, especially in Punjab and Sindh provinces. The report also warned that the population of the mealybug was still increasing and, if preventive measures were not taken, could result in an epidemic in the cotton-growing areas.

Hitherto, mealybugs were considered to be non-pest or at most as minor pests in sporadic instances, but now appears to be a major threat to cotton production in almost all cotton growing states of India and Pakistan. Apart from the yield losses, the pest infestation has increased the cost of insecticide application by US\$250–375 per acre in both India and Pakistan.

Interestingly, the mealybug species in Pakistan was identified as *Phenacoccus solenopsis* (Tinsley) (Zaka *et al.* 2006), which was not reported previously on any crop from India or Pakistan. Considering the sudden emergence of mealybug as a major pest of cotton across all cotton growing states of India and Pakistan, several questions are being raised to elucidate the reasons for pestilence. Information is clearly lacking on the composition of mealybug species that occur on cotton in various parts of India and on the predominant species that causes economic damage across the country. There is a great concern in India that an exotic species has been introduced accidentally and that it may create havoc, not only on cotton, but on other crops as well, thereby threatening sustainable agricultural production in the country. The present study is an attempt to understand the above aspects.

### Materials and methods

Mealybug populations were collected in perforated plastic containers approximately four–five inch shoots at random from ten infested cotton plants between July 2007 to February 2008 from a total of 47 cotton growing locations (fig. 1) at peak infestation stage in north, central and south India. Most of the places were covered once; however, some of the places were visited more than once. All the collected samples were reared on sprouted potato in the laboratory for taxonomic study. The samples from north India were from 13 locations representing seven cotton-growing districts (Abohar, Bathinda, Faridkot, Ferozepur, Ludhiana, Mansa and Muktsar) of Punjab; four districts (Bhiwani, Sirsa, Fatehabad and Hisar) of Haryana and two districts

(Sriganganagar and Hanumangarh) of Rajasthan. The survey covered 27 locations in central India with samples from 11 districts (Ahmedabad, Amreli, Anand, Vadodara, Bharuch, Bhavnagar, Junagarh, Porbandar, Rajkot, Surat and Surendranagar) of Gujarat; 15 districts of Maharashtra (Akola, Amaravati, Aurangabad, Beed, Buldhana, Dhule, Hingoli, Jalna, Latur, Nagpur, Nanded, Parbhani, Wardha, Washim and Yavatmal) and one district (Khandwa) of Madhya Pradesh. The survey in south India included a total seven districts with samples from five locations (Amaravathi, Guntur, Hyderabad, Karimnagar and Warangal) of Andhra Pradesh, one district (Dharwad) of Karnataka and one district (Coimbatore) of Tamil Nadu.

The mealybugs were mounted on slides (NPDN, 2004) and subjected to taxonomic identification based on the morphological characters of adult females as described by McKenzie (1967) and Williams & Granara de Willink (1992).

### Results

A total of 321 colonies of the mealybugs were examined, and results of the taxonomic study showed that all the samples collected on cotton plants from the surveyed sites comprised of only two mealybug species, the solenopsis mealybug, *Phenacoccus solenopsis* (Tinsley), and the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green). Of the 321 colonies examined, 304 were of the species *P. solenopsis*, which comprised nearly 95% of the samples collected from cotton crop. *P. solenopsis* was the predominant mealybug species that infested cotton throughout the country and caused significant economic damage. The exotic species *P. solenopsis*, which was hitherto not known to occur in India, appears to have assumed the status of a major pest on cotton. The occurrence of *M. hirsutus* on cotton still remains rare and sporadic like it had always been in India. A recent identification report by Suresh (2008) revealed five mealybug species: *P. solenopsis*, *M. hirsutus*, the solanum mealybug (*Phenacoccus solani* Ferris), the malvastrum mealybug (*Ferrisia malvastra* McDaniel) and the two-tailed mealybug (*Ferrisia virgata* Cockerell), in samples received from cotton researchers across India. However, we did not detect the three species, *P. solani*, *F. malvastra* and *F. virgata*, in any of the samples collected on cotton and examined by us.

### Discussion

*P. solenopsis* was described originally from the US, where it was widespread on ornamental and fruit crops (Tinsley, 1898). Fuchs *et al.* (1991) provided the first report of *P. solenopsis* infesting cultivated cotton and 29 other plant species of 13 families in the US. Subsequently, the species was also reported to occur in other crops in Central America, the Caribbean, Ecuador (Williams & Granara de Willink, 1992), Chile (Larrain, 2002), Argentina (Granara de Willink, 2003) and Brazil (Culik & Gullan, 2005). However, a report by Zaka *et al.* (2006) on the occurrence and widespread damage of *P. solenopsis* on cotton in Pakistan has caused much concern to the entire subcontinent. The report assumes significance because of the fact that the species *P. solenopsis* was not known to occur in India or Pakistan and no records exist of its infestation on any crop in either country. The above-mentioned reports indicate that *P. solenopsis* probably could have been introduced from the US into other infested areas around the world. Thus, *P. solenopsis* is being regarded

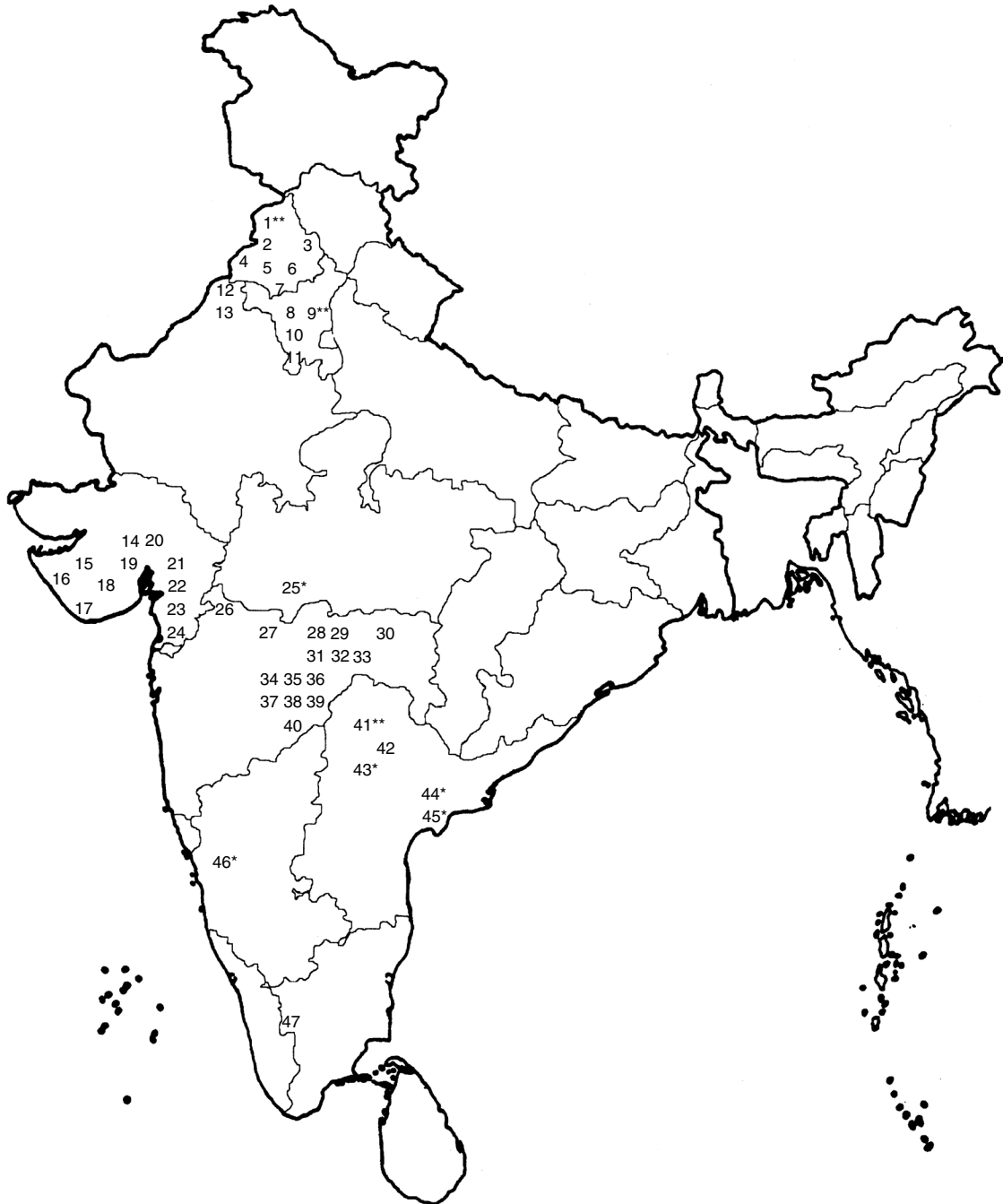


Fig. 1. Map of India indicating locations of insect collection.

\* *M. hirsutus*; \*\* both *P. solenopsis* and *M. hirsutus* while remaining numbers show *P. solenopsis*.

Numbers in the map (in parenthesis below) indicate the following mealybug collection sites. Punjab: Firozpur (1), Faridkot (2), Ludhiana (3), Muktsar (4), Abohar (5), Bathinda (6), Mansa (7), Haryana: Fatehabad (8), Sirsa (9), Hisar (10), Bhiwani (11), Rajasthan: Sriganganagar (12), Hanumangarh (13), Gujrat: Surendranagar (14), Rajkot (15), Porbandar (16), Junagarh (17), Amreli (18), Bhavnagar (19), Ahmedabad (20), Anand (21), Vadodara (22), Bharuch (23), Surat (24) Madhya Pradesh: Khandawa (25), Maharashtra: Dhule (26), Buldhana (27), Akola (28), Amaravati (29), Nagpur (30), Washim (31), Yavatmal (32), Wardha (33), Aurangabad (34), Jalna (35), Hingoli (36), Bid (37), Parbhani (38), Nanded (39) Latur (40) Andhra Pradesh: Karimnagar (41) Warangal (42), Hyderabad (43), Amravathi (44), Guntur (45) Karnataka Dharwad (46). Tamil Nadu: Coimbatore (47).

as an introduced exotic pest in India and Pakistan. However, it is still not clear as to how and when exactly the species would have entered into India and Pakistan.

Exotic pests, especially those that are polyphagous with a wide host range, establish themselves easily in the introduced countries, in the absence of their native, naturally occurring predators, parasitoids and pathogens. Moreover, pests such as the mealybugs establish and spread more easily than many other insect species since they: (i) possess a waxy coating on the dorsal side that protects them from insecticides and natural mortality factors; (ii) have a high reproductive rate; (iii) have the ability to hide in the soil, cracks and crevices of plants; and (iv) have the propensity to spread quickly through natural carriers such as plant products, wind, water, rain, birds, human beings and farm animals. Such insects have immense potential to emerge as crop pests, cause severe economic damage to a wide range of crops and pose a grave threat to agriculture in the introduced country. The host range of *P. solenopsis* includes several ornamental plants, fruit crops, vegetables and field crops belonging to at least 14 families in the US. Thus far, there are no published reports of *P. solenopsis* infesting any other crop in India. However, it is possible that the species, which is known to be highly polyphagous, may start infesting other crops over the next few years, thereby causing economic losses. Therefore, it is necessary to develop appropriate area-wide eco-friendly strategies for the management of *P. solenopsis* so as to prevent its spread, especially by ensuring that the management interventions do not disturb naturally occurring control of mealybugs and other insect pests.

For the effective prevention of mealybug infestation, regular monitoring of the pest is necessary. Mealybugs multiply on weeds (the most preferred is *Parthenium hysterophorus*) and move on to crop plants during the season. It is important to remove the weeds that grow on field bunds, water channels and wastelands in the area. Pigeonpea, *Cajanus cajan* (L.) Millsp., does not support the growth and multiplication of *P. solenopsis* (unpublished report of CICR, Nagpur), therefore cultivating border rows of pigeonpea as barrier crops around cotton fields and as a strip after five to six rows of cotton may also prevent mealybug infestation and spread. Timely detection and removal of infested plants along borders prevents further spread. Recommended insecticides (Tanwar *et al.*, 2007; Dhawan, 2008; Jhala & Bharpoda, 2008) with high eco-toxicity, such as methyl parathion (classified by the World Health Organization (WHO) as Class 1a: extremely hazardous), monocrotophos, dichlorvos, methomyl, triazophos and metasystox (Class 1b: highly hazardous) should be avoided. However, if plants are infested severely, the affected stems can be drenched with a systemic insecticide, such as acephate (Class III: slightly hazardous). Nevertheless, it is extremely important to avoid the usage of insecticides for the management of exotic pests, considering their propensity to survive, multiply and spread in the absence of native natural enemies. The ladybug beetle, *Cryptolaemus montrouzieri* (Mulsant), found to feed voraciously on *P. solenopsis* (unpublished report of CICR, Nagpur), can be released on weeds and perennial trees prior to the cotton season and during the season on infested cotton plants. However, further studies are essential to detect predators and parasitoids that may be occurring naturally in India to strengthen eco-friendly sustainable mealybug management. If the local natural enemies are inadequate for

effective control, it would become necessary to identify the most effective native natural enemies of the mealybugs in the country of its origin and import them into India for effective long-term sustainable management.

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