

Mealy Bugs Plague Bt Cotton in India and Pakistan

A potential agronomic nightmare that came with Bt cotton

Dr. Mae-Wan Ho

Mealy bug Bt cotton disaster in Punjab

“In the Malwa belt of rural Punjab, mile after mile of Bt cotton fields are under attack by the mealy bug pest,” a news feature reported in 2007 [1]. “Bathinda, Muktsar, Faridkot and Ferozepur, Punjab’s four major cotton-growing districts, have been badly affected. The so-called “magic bullet”, Bt cotton has turned into a bitter pill for farmers who were promised profits but who are now faced with huge losses.”

Bt cotton officially entered Punjab in 2005, but farmers began cultivating bootlegged varieties from Gujarat a year earlier. According to official statistics, around 60 percent of farmers in the state were growing Bt cotton by 2007, and almost 100 percent in the four cotton producing districts.

In contrast to Andhra Pradesh and elsewhere in India, Bt cotton in Punjab lived up to its promise of protecting against the American bollworm, and the number of sprays needed dropped from 30 to less than 5.

However, cotton is attacked by no less than 165 pests, and risks of resurgence of secondary pests are high.

In Andhra Pradesh, the number of attacks by aphids, thrips, jassids, etc. had risen since the introduction of Bt cotton in 2002. Tobacco leaf streak virus, tobacco caterpillars, etc have also emerged as new diseases and pests of Bt cotton. In 2007, reports of fungal root rot in Bt cotton were beginning to pour in from Warangal district in Andhra Pradesh.

Pesticides did not appear to be effective in controlling the mealy bug. Some farmers were uprooting the Bt cotton by hand and replacing it with paddy in order to recover some of their losses, but the price of rice was low.

“The writing on the wall is therefore quite clear for small farmers.” The new feature continued [1]. “Like in neighbouring Sangrur, the four cotton-growing districts of Punjab may soon begin reporting increasing numbers of farmer suicides.”

The central government Genetic Engineering Approval Committee had approved 135 varieties of Bt cotton by 2007, and had turned a deaf ear to the plight of cotton farmers in Punjab. Not only had Bt cotton brought disaster in the form of the mealy bug, it had also affected yields of the subsequent crop, wheat. Farmers reported up to 30 percent drop in wheat productivity on land that had previously cultivated Bt cotton. Similar reports came from Andhra Pradesh, where Kisan Call Centre in Hyderabad received a number of complaints from farmers on declining yields of crops cultivated after Bt cotton.

According to *Vyavsaya Panchangam*, a farmers' almanac published by the Acharya N G Ranga Agriculture University in Hyderabad, Bt cotton used more fertiliser than non-Bt cotton. If adequate amounts of fertiliser were not applied, the subsequent crop received fewer nutrients. Furthermore, the Bt toxin also expresses itself in the root zone of the plant and can affect soil biodiversity and ecosystem function, as reported in a study by the Australian government. These factors might account for the lower yields of subsequent crops; although there had been little attention paid to the matter.

Organic cotton escaped attack

Hartej Singh, an organic farmer associated with the Kheti Virasat Mission, grew cotton intercropped with rows of pigeon pea, sorghum, maize, soybean, cluster bean, and so on, some of which were leguminous crops used as green manure. His cotton crop consisted of F-1378, an early-maturing American variety, and LD 327, a high-yielding desi (indigenous) variety resistant to *Fusarium* wilt. His yields were slightly lower than those of the Bt cotton in neighbouring fields.

But while the neighbouring fields were heavily infested by the mealy bug, Singh's cotton crop was completely unaffected. That was so for the 100-odd farmers of the Malwa belt growing organic non-Bt cotton as part of the Kheti Virasat Mission.

Intercropping with several different crops stopped pests from migrating to the next row of cotton, and as these crops were never sprayed with pesticide, predators like beetle larvae could be seen feeding on the mealy bug. Whenever the pest concentration went up, a combination of neem leaves and pods, along with *Datura*, etc, mixed with cow urine, was sprayed on the crop to keep the pest under control.

The Bt cotton ‘success’ story

Bt cotton, genetically modified to make insecticidal protein(s) from the soil bacterium *Bacillus thuringiensis*, is held up as an example of a major ‘success’ of modern biotechnology in India, comparable to the Green Revolution decades earlier, according to the 2009 status report issued jointly by the Asia-Pacific Consortium on Agricultural Biotechnology and the Asia-Pacific Association of Agricultural Research Institutions [2]. First commercialized in 2002, Bt cotton spread rapidly, resulting in greatly increased productivity and reduced insecticide use. By 2009, production reached 49 million tonnes, bringing “considerable economic benefits...to farmers of all states.” Bt cotton hybrids now cover 7.6 million hectares, nearly 81 percent of India’s cotton growing land, and over 600 Bt hybrids have been released for commercial cultivation. More than 35 seed companies and public sector institutions are engaged in their development. A true-breeding variety has also been released by the Indian Council of Agricultural Research, so farmers can save their own seed.

The status report dismissed any link between Bt cotton and farmers’ suicides [2] (see [3] [Farmers’ Suicides in India, Over Half Linked to Bt Cotton](#), *SiS* 45), but did not deny that secondary pests such as the mealy bug have emerged. The latter was attributed to the reduced spraying of pesticides after Bt cotton was introduced, which had kept those pests under control in the past. But findings on the ground and in the laboratory tell a different story.

Deadly gift from Monsanto

Early in 2008, organic farmer Ram Kalasapurkar of Yavatmal, Maharashtra in India had sent us vivid photographic evidence of mealy bug infestations on demonstration plots of different seed companies in Vidarbha, all bearing the Bollgard label [4] ([Deadly gift from Monsanto to India](#), *SiS* 38). He was convinced that the mealy bug entered Vidarbha cotton fields through Bt cotton seeds imported from the United States.

Kalasapurkar described how, when the cotton plants died at the end of the season, the mealy bugs moved to nearby plants such as the Congress weed. By mid-June when farmers are ready to plant the new cotton crop or another crop, the bug would have multiplied enormously.

Scientists confirm the exotic origin of the mealy bug plague

A year later, scientists at the Central Institute for Cotton Research (CICR) in Nagpur, India, corroborated Kalaspurkar's findings, reporting widespread infestation of an exotic mealy bug species on Indian cotton [5].

The scientists conducted a survey at 47 locations in the nine cotton-growing states, and found only two mealy bug species infesting the cotton plants from all nine states: the solenopsis mealy bug, *Penacoccus solenopsis*, and the pink hibiscus mealy bug, *Maconellicoccus hirsutus*. However, *P. solenopsis* was the predominant species, comprising 95 percent of the samples examined. Furthermore, the scientists confirmed that *P. solenopsis* is a new exotic species to India originating in the US, where it was reported to damage cotton and other crops in 14 plant families.

Mealy bugs (Hemiptera: Pseudococcidae) are small sap-sucking Insects, and some species cause severe economic damage to a wide range of vegetables, horticultural and field crops. Infested plants can exhibit general symptoms of distorted and bushy shoots, crinkled and/or twisted bunchy leaves, and stunted plants that may dry completely.

Historically, mealy bugs were never considered major pests of cotton in India. There have been isolated reports of *M. hirsutus* on the native 'desi' species, *Gossypium arboreum* in Punjab and on the new world cotton *Gossypium herbaceum* in Gujarat. But no published evidence of mealy bugs on *Gossypium hirsutum* which currently occupies more than 80 percent of the cotton cultivated in the country.

The scientists surveyed 27 locations in central India with samples from 11 districts of Gujarat, 15 districts of Maharashtra and one district of Madhya Pradesh. The survey in south India included a total of seven districts, five from Andhra Pradesh, one from Karnataka and one from Tamil Nadu.

A total of 321 colonies of the mealy bugs were examined under the microscope; and 304 were *P. solenopsis* (nearly 95 percent). *P. solenopsis* was the predominant species that infested cotton throughout the country and caused significant economic damage. The occurrence of *M. hirsutus* remained sporadic and rare.

P. solenopsis was described originally from the US, where it was widespread on ornamental and fruit crops. The first report of *P. solenopsis* infesting cultivated cotton and 29 other plant species of 13 families was published in 1991. Subsequently, the species was reported on other crops in Central America, the Caribbean, Ecuador, Argentina and Brazil, all probably introduced from the US.

Economic damages from the mealy bug in India and Pakistan

During 2006, the mealy bug caused economic damage, reducing yields by up to 40-50 percent in infested fields in several parts of Gujarat [5]. At around the same time, mealy bug infestations were found in all the nine cotton-growing states: Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka. Severe economic damage was reported in 2007 in four districts of Punjab, two districts of Haryana, and low to moderate damage in parts of Maharashtra, Tamil Nadu and Andhra Pradesh. Nearly 2 000 acres of cotton crop were destroyed by the mealy bug by mid-July, and over 100 acres of bug-infested Bt cotton was uprooted in Arike-Kalan village in Bathinda. By the end of the Kharif (autumn) season (June-October), the total damage in 2007 was estimated to range from US\$400 000 to 500 000 in north India alone.

A report published by the Centre for Agro-Informatics Research in Pakistan in 2006 [6] also stated that the exotic mealy bug *P. solenopsis* had destroyed 0.2 million bales and 50 000 acres (out of the 8 million acres) of cotton area across Pakistan, especially in Punjab and Sindh provinces. It warned that the pest was still increasing, and could result in an epidemic in the cotton-growing areas if unchecked.

The mealy bug has become a major pest in almost all cotton growing states of India and Pakistan. Apart from yield losses, the cost of insecticide application has increased by US\$250-375 per acre in both India and Pakistan [5].

A potential mealy bug nightmare that can only be contained biologically

Exotic pests with a wide host range such as the mealy bug can easily establish themselves, as they are missing their naturally occurring predators, parasitoids and pathogens. Moreover, the mealy bug has a waxy coating on its back that protects it from insecticides and other poisons that might kill them; they also have a high reproductive rate, an ability to hide in the soil, cracks and crevices of plants and the propensity to spread quickly through natural carriers such as plant products, wind, water, rain, birds, human beings and farm animals. Worse yet, they have the potential to infest other crops besides cotton.

The CICR scientists [5] recommend removing the preferred weed *Parthenium hysterophorus* on which the mealy bug multiplies and moves onto crop plants during the season. Planting border rows and strips (every 5-6 rows of cotton) of Pigeonpea *Cajanus cajan* (L.) Millsp., which does not support the growth and multiplication of *P. solenopsis*, would help control the pest. Timely detection and removal of infested plants along borders of crop will prevent further spread of the pest.

The CICR scientists also warned *against* using the recommended highly eco-toxic insecticides, which such as methyl parathion (classified by World Health Organization as Class 1a, extremely hazardous), monocrotophos, dichlorvos, methomyl, triazophos and metasystox (Class 1b, highly hazardous).

The scientists stated that [5], “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. They recommended introducing the ladybug beetle, *Cryptolaemus montrouzieri* (Mulsant), which they found to feed voraciously on *P. solenopsis*. These could be released on weeds and perennial trees prior to the cotton season, and during the season on infested cotton plants.

The scientists stressed that further studies are essential to detect predators and parasitoids that may be occurring naturally in India to strengthen eco-friendly sustainable mealy bug management. Otherwise it would be necessary to import their natural enemies from the US.

Their findings have been confirmed in a subsequent paper [7] by taxonomist Mohammed Hayat, who even isolated a parasitoid, *Aenasius* from the exotic mealy bug pest *P. solenopsis*.

When asked why it is so important to find out if the pest is an exotic species [8], CICR Acting Director and an award-winning cotton scientist Keshav Kranthi replied: “Because it has to be officially declared as an exotic pest to be able to come out with a pest management regimen for it.”

“The bug badly called for a control regimen to be put in place, especially against the observation that if sprayed with pesticides, it only grows due to the wax-like coating on its back.” Kranthi added.

The study by CICR team confirmed that the growth of the mealy bug menace can be attributed to the decimation of the parasitoids feeding on the pest [8]. This was why the year before, CICR issued the advice that no pesticides should be sprayed on the cotton crop, at least in the initial stages of crop growth, to let the parasitoids live on, as it is they that would naturally eliminate the bug.

Kranthi claimed that if left without pesticide spray, the mealy bug would get decimated by the parasitoid in a couple of years.

CICR has evolved a management package for controlling the mealy bug, which consists mainly of symptomatic control without spraying pesticides at early crop stage, continuous monitoring of infestation, destruction of cotton stalks after picking, and use of botanical and biological control formulations like neem seed kernel extract and biopesticides at different stages.

According to the press report [8], there was a sudden invasion of mealy bugs on Bt cotton in Gujarat in 2004, from which it spread to almost the entire country and even neighbouring Pakistan in the next two years, causing substantial economic damage in 2007 (see above). It also brought a bad name to Bt cotton, as the mealy bug easily infested the transgenic variety, although it was not supposed to require pesticides.

References

1. "India: Bt cotton devastated by secondary pests", Bhaskar Gowmai, InfoChange News & Features, India, 1 September 2007, <http://www.infochangeindia.org/features441.jsp>; <http://www.grain.org/btcotton/?id=398>
2. Karihaloo JL and Kumar PA. Bt cotton in India, a status report (Second Edition), 2009, Asia-Pacific consortium on Agricultural Biotechnology, Asia-Pacific Association of Agricultural Research Institutions, http://www.apcoab.org/documents/bt_cotton2.pdf
3. Ho MW. Farmers' suicides in India, over half linked to Bt cotton. *Science in Society* 45 (to appear).
4. Kalasurkar R. Deadly gift from Monsanto to India. *Science in Society* 38, 51, 2008.
5. Nagrare VS, Kranthi S, Biradar VK, Zade NN, Sangode V, Kakde G, Shukla RM, Shivare D, Khadi BM and Kranthi KR. Widespread infestation of the exotic mealybug species *Phenacoccus solenopsis* (Tinsley) (Homoptera: Pseudococcidae) on cotton in India. *Bulletin of Entomological Research* 2009, 99, 537-41.
6. Zaka SM, Saeed S, Bukhari SA & Baksh E. Mealybug, *Phenacoccus solenopsis* (Homoptera: Pseudococcidae): A novel pest of cotton in Pakistan. 32 pp. in Proceedings of 34th Pakistan (SAARC) Countries Science Conference. University of Veterinary and Animal Sciences, February 8–10, 2006. Lahore, Pakistan, cited in ref. 3.
7. Hayat M. Description of a new species of *Aenasius Walker* (Hymenoptera: Encyrtidae), parasitoid of the mealybug, *Phenacoccus solenopsis* Tinsley (Homoptera: Pseudococcidae) in India. *Biosystematica* 2009, 3, 21-26.
8. "Mealybug species, the Bt cotton killer, is exotic", Vivek Deshpande, Indian express, 17 July 2009, <http://www.indianexpress.com/news/mealybug-species-the-bt-cotton-killer-is-exotic-experts/490540/0>