

Survey for cotton mealybug, *Phenacoccus solenopsis* (Tinsley) and its natural enemies

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Abstract

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Mealybug was considered to be a minor pest of cotton but it emerged as a major pest in 2006-2007 in North and Central zones. Extensive field surveys conducted in cotton fields during 2007-09 in Haryana, Rajasthan and Punjab in the North zone and Madhya Pradesh, Maharashtra and Gujarat in the Central zone indicated that *Phenacoccus solenopsis* was the only major species of mealybug recorded on cotton in North as well as Central zones except one location in Gujarat where *Ferrisia virgata* Cockerell was also recorded. Infestation of mealybug at most of the places in North and Central zones ranged from mild (10-20%) to high (40-60%) during 2007 and 2008 but reduced to traces in 2009. Extensive field survey indicated that *Aenasius bambawalei* Hayat (Chalcidodea: Encyrtidae), an indigenous parasitoid, played a key role in reducing the insect pest infestation. The parasitoid was first recorded in Delhi in July 2008 and by 2009 it was found in most of the cotton growing districts of North and Central zones. Its natural parasitization on *P. solenopsis* could reach more than 90% at many locations. This is the most successful example of biological control of mealybug. Along with this parasitoid, another parasitoid, *Promuscidea unfasciiventris* Girault (Chalcidodea: Aphelinidae), was also recorded at most of the locations in smaller proportions.

Key words

Mealybug, *Phenacoccus solenopsis*, Parasitoid, *Aenasius bambawalei*, *Promuscidea unfasciiventris*

Introduction

Mealybug was noticed to appear on cotton crop in India from 2003-04 onwards (Jhala *et al.*, 2008). This coincided with the introduction of *Bt* cotton, its rapid adoption by the farmers, effective control of the bollworms and reduction in pesticide use. The pest became a threat to *Bt* cotton by 2006 and 2007 in Punjab, Haryana, Rajasthan, Gujarat and Maharashtra (Tanwar *et al.*, 2007) and caused significant losses in cotton production. The species was identified as *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae) which is a new species to cotton in India. Roving survey carried out in Baroda during November 2006 revealed that 25-30% cotton fields were infested with mealybug and 20-90% plants were adversely affected causing a reduction of 50% yield in highly infested fields (Jhala *et al.*, 2008). In Punjab the losses

caused by the mealybug were estimated to be Rs. 159 crores to cotton growers during *kharif* season 2007 (Anonymous, 2008). Study carried out in Punjab of Pakistan during 2007-08 indicated losses to the tune of 3.1 million bales from the targeted output of 14.3 million bales due to mealybug (Anonymous, 2007). As the pest was invading fast in newer areas, therefore, there was an urgent need to collect information on its distribution, infestation and natural enemies in different cotton growing zones which would help in formulating the integrated management strategy for this species. The present study was aimed to conduct survey in cotton fields in Haryana, Rajasthan, Punjab, Madhya Pradesh, Maharashtra and Gujarat during 2007-09 to find out the distribution, infestation level and natural enemies of *P. solenopsis* which would help in formulating the integrated management strategy for mealybug in cotton.

Materials and Methods

Field survey were conducted in *Bt* and non *Bt* cotton fields and weeds around cotton fields in intensive cotton growing areas of Punjab, Haryana and Rajasthan (September, 2007, August, 2008 and August, 2009, respectively), Gujarat (November, 2008), Maharashtra (August, 2008) and Madhya Pradesh (December, 2008) for mealybug and its natural enemies. During the survey, the villages which were located near road side and having large area under cotton, were selected randomly. Around 10-15 km distance was maintained between two villages for survey and in each village two or three cotton fields were selected. At each location 5 spots were selected for observing 20 plants at each spot for healthy as well as mealybug infested plants. The mealybug colonies were closely observed for species identification and presence of mealybug mummy containing parasitoid or its emergence hole. Identification of *P. solenopsis* was based upon the presence of short to medium sized waxy filaments around the body and anal filaments about one-fourth the length of the body and two dark stripes on either side of the middle "ridge" of the body. This species produces oviscap which is generally present below the female's body. To score the per cent parasitization, total numbers of mealybugs were counted along with the mealybug mummies which appeared dark brown in colour. A small piece of plant containing these mealybug mummies was separated from the plant and kept in plastic jars provided with brass mesh for proper ventilation for emergence of parasitoids in the laboratory. The emerged parasitoids were preserved in 70% alcohol and got identified from Insect Identification Service, Division of Entomology, IARI, New Delhi. Samples of mealybug cadavers were also collected from different places. The insect pathogens found associated with other symptoms on the pest cadavers were isolated and cultured on PDA medium. These pathogens were got identified from Indian Type Culture Collection (ITCC), Division of Plant Pathology, New Delhi. During the survey, the predators feeding on the mealybugs were also recorded, especially ladybird beetles.

Results and Discussion

Mealybug and its parasitoids

North zone (Punjab, Haryana, Delhi and Rajasthan): Survey conducted in Hisar, Fatehabad and Sirsa districts of Haryana indicated mild (10-20%) infestation of mealybug during 2007 which gradually increased to moderate (20-40%) in 2008 and reduced to traces in 2009 (Table 1). In Punjab, the mealybug infestation was high (40-60%) during 2007, moderate (20-30%) in 2008 and became negligible in 2009. Survey conducted at IARI Campus, Pusa indicated the mealybug infestation to be moderate (20-40%) in 2007, mild (10-20%) in 2008 and negligible in 2009. In Rajasthan, mealybug appeared only in a few districts having irrigation facilities and adjoining Punjab and Haryana. In these districts, infestation remained negligible in 2007, mild (10-20%) in 2008 and again reduced to traces in 2009. During the field survey, *P. solenopsis* was found to be the only species of mealybug recorded on cotton in the North.

A natural parasitoid of mealybug appeared in Delhi during July and August, 2008 on *P. solenopsis* on different host plants

such as cotton, okra, *Parthenium hysteropus*, *Xanthium strumarium*, *Achyranthes asper*, etc. At the early stage of parasitization, the colour of mealybug was changed. The mealybug mummies formed due to parasitization could be easily identified by their dark brown colour in white mealybug colony. The parasitoid was identified as *Aenasius bambawalei* Hayat (Chalcidodea: Encyrtidae) by Insect Identification Service, Division of Entomology, IARI, New Delhi. This was the first record of the parasitoid in India (Tanwar et al., 2008; Hayat, 2009). Its parasitization on mealybug on these plants ranged from 20-70%. This parasitoid was later on reported from Hisar (Haryana) in September, 2008 (Ram et al., 2009). Field survey conducted by the authors in September, 2009 indicated the presence of the parasitoid in Haryana, Punjab and Rajasthan (Table 1). In Hanumangarh district of Rajasthan its parasitization could reach > 90%. At all the locations the parasitoid was able to parasitize the mealybug even at low level of infestation. In general, at all the locations where *A. bambawalei* was present another parasitoid, *Promuscidea unfasciiventris* Girault (Chalcidodea: Aphelinidae) was also observed. This species had earlier been reported as a hyperparasitoid on the encyrtid (Hayat, 1998).

Central zone (Maharashtra, Madhya Pradesh and Gujarat)

Mealybug infestation in different villages of Vadodara, Bhavnagar, Rajkot and Surendernagar districts of Gujarat ranged from traces to severe (>60%) (Table 2) in November, 2008. *P. solenopsis* was the only species recorded at most of the places in Gujarat except Surendernagar district (Sanosara village) where tailed species i.e., *Ferrisia virgata* Cockerell was also observed in a few cotton fields located near custard apple orchard. It was interesting to note that *desi* variety at most of the places remained free from mealybug infestation. Moreover, *P. solenopsis* at all the places was found to be parasitized by *A. bambawalei* with its range of parasitization from 30-70%. At Bhaduka village of Surendernagar district, almost all the mealybugs were found to be parasitized by this parasitoid.

In Maharashtra, field survey was conducted during August, 2008 in five cotton growing Tehsils of Parabhani. Mealybug infestation in different cotton fields ranged from traces to 60.6% (Table 3). *P. solenopsis* was the only species recorded at most of the places in Parabhani which was found to be parasitized by a hymenopterous parasitoid and its parasitization on cotton as well as on *Parthenium* was upto 87.3% (Table 3). The collection and identification of samples indicated the presence of *A. bambawalei* and *P. unfasciiventris*.

Survey conducted near Khandwa in Madhya Pradesh in December, 2008 indicated that most of the cotton fields in Jeswadi, Jelkuan, Piplia and Rajgarh villages were free from mealybug infestation. Weeds present near cotton fields were also free from mealybug. At JNKVV Research Farm, Khandwa (M.P.), most of the fields were free from mealybug but a few plants in breeding trial were severely infested with *P. solenopsis*. Mealybug mummies which contained the parasitoid pupae were also visible in different mealybug colonies. From these mummies the parasitoids *A. bambawalei* and *P. unfasciiventris* emerged under laboratory conditions.

Table - 1: *P. solenopsis* infestation and its parasitization on cotton in the North zone (2007-09)

State	District	Villages	<i>P. solenopsis</i> infestation (%)			Parasitoids recorded		
			2007	2008	2009	2007	2008	2009
Delhi	New Delhi	IARI Res. Farm	20-40	10-20	Tr.	-	<i>A. b.</i>	<i>A. b.</i> , <i>P. u.</i>
Haryana	Hisar	Dhiranwas, Bhatla, Muklan, Raipur	10-20	20-40	Tr.	-	<i>A. b.</i>	<i>A. b.</i> , <i>P. u.</i>
		Fatehabad	10-20	20-40	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>
		Sirsa	10-20	20-40	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>
Punjab	Firozpur	Bhagwanpura and Balluana	40-60	20-30	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>
	Muktsar	Kaundal, Mohlan, Mahabadar, Bhalliana and Kotbhai Dhani	40-60	20-30	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>
	Bhatinda	Giddarbha and Behman Diwan	40-60	10-20	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>
Rajasthan	Hanumangarh	Sangaria	Tr.	20-30	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>
		Bhagatpura	Tr.	Tr.	Tr.	-	-	<i>A. b.</i> , <i>P. u.</i>

(*A. b.* = *A. bambawalei*; *P. u.* = *P. unfasciiventris*; Tr. = Traces)

Table - 2: Infestation and parasitization of mealybug in different villages of Gujarat during 2008

District	Village	<i>P. solenopsis</i> infestation (%)	Parasitoids recorded
Vadodara	Karavan, Kandha and Pingalwada	10-20	<i>A. b.</i> , <i>P. u.</i>
	Timbermava, Dhavat	20-40	<i>A. b.</i> , <i>P. u.</i>
	Vemur	40-60	<i>A. b.</i> , <i>P. u.</i>
Bhavnagar	Dhanduka (Dhanduka Taluka) and Botado (Botado Taluka)	Tr.	<i>A. b.</i> , <i>P. u.</i>
	Tagadi (Dhanduka Taluka)	40-60	<i>A. b.</i> , <i>P. u.</i>
	Tagadi*	>60	<i>A. b.</i> , <i>P. u.</i>
	Hamapur and Madavadhal villages (Gadyhada Talauka)	40-60	<i>A. b.</i> , <i>P. u.</i>
Rajkot	Vadod	20-60	<i>A. b.</i> , <i>P. u.</i>
Surendernagar	Thikariyala, Shaikpur	Tr.	-
	Sanosara	40-60	<i>A. b.</i> , <i>P. u.</i>
	Bhaduka	40-60	<i>A. b.</i> , <i>P. u.</i>
	Lakhtar and Sardo**	No infestation	-

(*A. b.* = *A. bambawalei*; *P. u.* = *P. unfasciiventris*; Tr. = Traces), **Desi* variety was free from mealybug infestation, **Only *Desi* variety grown

Table - 3: Mealybug infestation and its parasitization by hymenopterous parasitoids in different Tehsils of Prabhani (Maharashtra) during 2008

Tehsil	Village	Mealybug infestation (%)	Parasitization (%)	Parasitoids recorded
Parabhani	Hasnapur	30.4	33.7	<i>A. b.</i> , <i>P. u.</i>
	Brahamangaon	60.3	17.4	<i>A. b.</i> , <i>P. u.</i>
Manwat	Kolhawadi	30.8	75.6	<i>A. b.</i> , <i>P. u.</i>
	Manawat	25.3	-	<i>A. b.</i> , <i>P. u.</i>
Pathri	Pathri	Tr.	-	<i>A. b.</i> , <i>P. u.</i>
	Jaydapur	Tr.	-	<i>A. b.</i> , <i>P. u.</i>
	Veta	60.6	38.5	<i>A. b.</i> , <i>P. u.</i>
Gangakhed	Mahatpuri	11.3	-	<i>A. b.</i> , <i>P. u.</i>
	Sayala	10.4	87.3	<i>A. b.</i> , <i>P. u.</i>
Sonpet	Shalegaon	5.6	-	<i>A. b.</i> , <i>P. u.</i>

(*A. b.* = *A. bambawalei*; *P. u.* = *P. unfasciiventris*; Tr. = Traces; - = no parasitization)

It is evident that mealybug which acquired the status of a major insect pest in most of the cotton growing districts in the North and Central zones, had been successfully checked by its indigenous parasitoid, *A. bambawalei* at most of the locations surveyed. The parasitoid was first recorded in Delhi in July 2008 and was further found at most of the cotton growing districts of North and Central zones. At Raichur among five Hymenopteran and dipteran parasitoids recorded, *A. bambawalei* was the most pre dominant parasitoid (Hanchinal et al., 2010). In the present study, along with this parasitoid, the other parasitoid, *P. unfasciiventris* was also recorded at most of the locations surveyed. This parasitoid is considered to be hyperparasitoid and it is expected that it may adversely affect the efficacy of *A. bambawalei* (Muniappan, 2009). However, it is interesting to note that at most of the places *P. unfasciiventris* was present along with *A. bambawalei* and at all these locations the mealybug was successfully checked. In the literature, *P. unfasciiventris* has also been reported as primary parasitoid of coccids (Sureshan and Narendran, 2005). Though the parasitoid (*A. bambawalei*) has now been well established on *P. solenopsis* on different host plants especially the weeds which remained uncared for by the farmers and provides a continuous source of parasitoids for mealybugs attacking cotton and other crops, yet there is a need to conserve the parasitoid in the nature. This is the most successful example of biological control of mealybug by a hymenopterous parasitoid.

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