Phenacoccus saccharifolii (Green) (Pseudococcidae: Hemiptera) on sugarcane in Tamil Nadu, India

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In this study, we report *Phenacoccus saccharifolii* (green) on sugarcane in Tamil Nadu, India, though an earlier unreported isolated occurrence was observed by us in the farmers' fields at Pugalur, Tamil Nadu. This pest has now become a major threat to sugarcane cultivation across the state as it can often kill the infested canes with or without the association of the fungal disease, pokkah boeng. Field observations revealed that the ratoon crop was affected more than the plant crop in the same locality. This species was found in large colonies, primarily between the –2 and +1 leaf of the sugarcane plant and hence, named as crown mealybug. Infestation leads to severe mottling in the leaf whorl and death of the central shoot. To the best of our knowledge, there are no earlier studies on the occurrence of this mealybug on *Saccharum spontaneum* L. Well-developed colonies showed high activity of three encyrtid parasitoids, viz. *Aenasius phenococci* (Ashmead), *Aenasius arizonensis* (Girault) and *Leptomastix dactylopii* Howard in the areas surveyed.

Keywords: Encyrtid parasitoids, fungal disease, infestation, *Phenacoccus saccharifolii*, *Saccharum spontaneum*, sugarcane.

SUGARCANE, a long-duration crop of 12–14 months and sometimes cultivated as a crop of 18 months (adsali) in certain locations, is subjected to climatic vagaries across seasons. At least 220 species of pests occur on sugarcane at different growth stages, with their pest status dependent on the agro-climatic zones[1]. In India, the high incidence of insect pests and diseases is a critical issue in achieving higher sugarcane production[2]. Though, in general, cane borers and root grubs are significantly destructive, sucking pests are sporadic, seldom a problem of serious consequence necessitating intense monitoring and alacritous management. Their damage is often viewed as a corollary of either climatic vagary or poor crop husbandry and rarely of both.

However, lately, sucking pests have undergone a major shift in pest status in sugarcane. Reports of change from minor to major pest status and occurrence in newer, previously unknown areas of incidence are on the rise. For example, the invasion of southern India by woolly aphid *Ceratovacuna lanigera* Zehtner on a substantial scale and the subsequent serious losses in 2004–2012 (refs 3–5) were in contrast to the innocuous status the pest had previously displayed in its native state of West Bengal[6]. Likewise, recently, *Phenacoccus saccharifolii* (Green), a mealybug affecting the sugarcane's crown region, has appeared in newer areas of sugarcane cultivation. Of the six mealybug species infesting sugarcane in India, only *Saccharicoccus sacchari* (Cockerell) and *Kiritshenkella sacchari* (Green) are more common than *Pseudococcus saccharicola* Takahasi, *Antonina graminis* (Maskell), *Dysmicocccus carens* Williams and *P. saccharifolii*[7]. Recently, *P. saccharifolii* has emerged in devastating proportions in Tamil Nadu, where it has never been previously reported. Several species of *Phenacoccus* have been recorded as invasive mealybugs in India, often expanding their host range or area within the country, or assumed to have reached more severe proportions than their status in earlier records. Examples of such a phenomenon on other crops include *Phenacoccus solenopsis* Tinnsley on cotton[8], jute[9] and cashew[10], *Phenacoccus madeirensis* Green on cotton[11], *Phenacoccus parvus* Morrison on Naga king chili[12], China aster[13] and *Phenacoccus manihoti* on cassava[14].

P. saccharifolii was observed on sugarcane (*Saccharum* spp. hybrid cv Co 06022) plants for the first time in India, Pugalur at Tamil Nadu (11°04′26.43″N, 78°01′15.41″E) as an isolated case in a single field, and later in the ICAR-Sugarcane Breeding Institute (ICAR-SBI), Coimbatore in pot culture and field (cv. Co 86032; 11°0′21″N, 76°55′6″E and 11°0′19″N, 76°55′2″E respectively). Specimens were sent for identification from the Coimbatore collection, as these mealybugs were hitherto not observed on sugarcane in Tamil Nadu. Immediately thereafter, a new mealybug infestation was reported from other parts of Tamil Nadu and surveys by a team from ICAR-SBI were undertaken. This

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study discusses the outcomes of mealybug infestation at ICAR-SBI as well as the surveys carried out in commercial plantations.

Materials and methods

Surveys

Two surveys were carried out in villages of Tamil Nadu to assess the type, extent and causes of mealybug outbreak. The first field survey was conducted in July 2021 in the sugarcane belt under the aegis of M/s Salem Co-Operative Sugar Mills, Mohanur. The second survey was in September 2021, in the area earmarked for Kothari Sugars (Kattur and Sathamangalam). Per cent incidence was assessed in one of the surveys, based on the number of clumps affected among 100 clumps sampled as 10 clumps each at 10 different spots. Damage was further assessed on a scale of 1–4 with any two conditions fulfilled.

Grade 1. Bare infestation – few mealybugs in the leaf blade; no mottling; one tiller or cane in a clump affected.

Grade 2. Visible infestation – no mottling; infestation in less than 25% of leaf length in the sampled leaf; scarce sooty mould; infestation in at least 25% of the total number of tillers or canes in a clump.

Grade 3. Prominent infestation – severe mottling; heavy sooty mould; 50% of leaf length occupied in the sampled leaf; 50% of the total number of tillers or canes in a clump.

Grade 4. Population peak – leaf drying; heavy sooty mould; dead heart; aerial sprouting; 75% or more of at least one leaf or leaf sheath occupied by the colonies; infestation in 75% or more of the total number of tillers or canes in a clump.

In the pot culture of Co 86032, the initial population was observed. The colony specimens were packed in 70% alcohol and sent for identification to ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru and Tamil Nadu Agricultural University (TNAU), Coimbatore. The colonies were observed for their growth and development without any intervention. Samples were drawn at periodic intervals to observe the eggs, nymphs, male cocoons, adults as well as natural enemies. The specimens were observed under a microscope in the laboratory to obtain details about the microscopic features. Damage potential, the pattern of colony spread and symptoms were observed. Activity of the predators on the mealybug was monitored. Regular incubation of infested leaves to observe parasitoid emergence and predator activity was carried out. The parasitoids and predators were identified based on bibliographical surveys[15–22] and by comparison of photographs at the websites of research institutes and images in several research publications. Ant activity and other behavioural aspects of the colony were observed. The colony characters were observed in infested plants in pot culture and research farms at ICAR-SBI. Data on per cent incidence of *S. spontaneum* and *Erianthus arundinaceus* clones that were maintained at ICAR-SBI were also recorded.

Observations in the laboratory

Specimens from the field were transferred onto 20-day-old seedlings of sugarcane for observation of nymphs and adults. Studies on mating were made by rearing a mature female on a sugarcane leaf bit in a cavity block or 5 ml capacity eppendorf tube or 20-day-old potted plants (Figure 1 *a–f*). The frequency of mating was observed by allowing an unmated single male either once or multiple times. The colonies on leaves harvested from the field were observed under a microscope (Carl Zeiss Stemi SV 6) to study the morphological features of nymphs and adults. The ovisacs were teased and observed for eggs under the microscope. Photographs of morphological details of the mealybugs were taken using a scanning electron microscope (SEM; FEI Quarta 250, Everhart Thornley Detector) with a tungsten heated filament under a low vacuum and through slides made of the mealybug.

Results and discussion

Identification

The mealybug collected from ICAR-SBI was identified as *Phenacoccus saccharifolii* (Green) by ICAR-NBAIR, Bengaluru and confirmed by TNAU, Coimbatore.

Mealy bug occurrence

During field surveys, irregular distribution of the mealybug was observed. Infestation was 10–40% of the sampled clumps. The scale of infestation using the mentioned methodology was found to vary in the range 1–4, with an average of 3.1 grading in the first survey done in July 2021.

In a field survey conducted during July 2021 in the sugarcane belt of Mohanur in the villages of Kidaram (11.0494°N, 78.1782°E), Kattuputhur (10.9961°N, 78.2163°E), Pettapalayam (11.0711°N, 78.1272°E), Muthur (11.0444°N, 77.7352°E), Periyakarasapalayam (10.7748°N, 77.3131°E) and Ellaimedu (11.0970°N, 78.0541°E) in Tamil Nadu, concomitant occurrence of the mealybug and pokkah boeng was observed in Kidaram on Co 0212 and CoC 24, in Kattuputhur on Co 06022 and in Pettapalayam on Co 06022 in ratoon crops. Heavy bud sprouting and restricted terminal growth were also observed. In Kattuputhur, a plant crop of Co 11015 in an area of 2.5 acres was free of mealybug infestation. It could be observed that a ratoon crop of CoM 0265 in Muthur, and of Co 06022 at Periyakarasapalayam, and a plant crop of Co 06022 at Periyakarasapalayam were free from *P. saccharifolii* incidence due to insecticidal application.

Subsequent field surveys conducted during September 2021 in Kattur and Sathamangalam of Tamil Nadu in 17 different fields located in the villages of Valadi (10.8763°N, 78.7575°E), Kothamangalam (10.0603°N, 76.6352°E), Mettupatti (11.6648°N, 78.3117°E), Alangudimahajanam

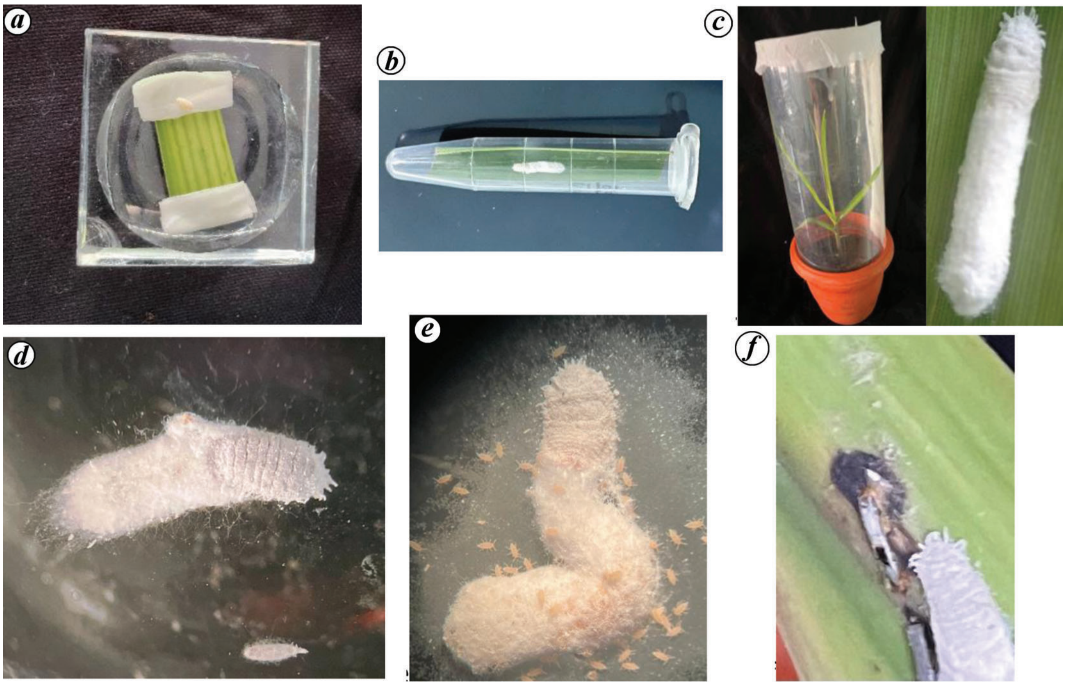

Figure 1. Experimental set-up of laboratory studies. ***a***, Incubation of mealybug in a cavity box. ***b***, Incubation in an eppendorf tube. ***c***, Incubation in a pot and female with extended ovisac. ***d***, A female with ovisac and male cocoon. ***e***, Crawlers emerging from the ovisac. ***f***, Necrotic spot of feeding by the female.

Figure 2. Mealybug-infested field of Co 86032.

(10.3611°N, 78.9796°E), Kattur (10.7930°N, 78.7445°E), Poovalur (10.9612°N, 79.6600°E), Peruvalanallur (10.9207°N, 78.8408°E), Aalampadi (11.4653°N, 79.6141°E), Annimangalam (11.3262°N, 78.7944°E) and Thirumalapadi (10.9010°N, 79.0546°E) with varieties CoV 09356 (ratoon), Co 86032 (I ratoon), Co 06022 (I ratoon), Co 06022 (III ratoon), Co 86032 (plant crop), Co 11015 (plant crop), Co 06022 (I ratoon), Co 09356 (I ratoon), Co 86032 (plant crop), CoV 09356 (III ratoon), Co 06022 (I ratoon), CoV 92102 (I ratoon), CoV 92102 (III ratoon), Co 0630 (I ratoon), CoG 7 (plant crop) Co 0212 (I ratoon) and Co 11015 (plant crop), CoV 92102 (IV ratoon) and Co 11015 (plant crop) also showed different levels of infestation of mealybugs and pokkah boeng.

Nature of infestation as influenced by management

In general, ratoon crops showed higher mealybug incidence than plant crops and occasionally mealybug infestation and pokkah boeng, i.e. 4 out of 17 fields (23.59% probability) had a combined attack of pest and disease, compounding the damage. Co 06022 and CoV 09356 (ratoons) showed alarming levels of mealybug and pokkah boeng incidence. The infestation seemed more fortuitous than fortitude as the fields (PI 1110) adjacent to those critically infested (CoV 09356) were observed to have escaped the mealybug infestation. The variety CoG 6 had suffered extreme damage due to both mealybug and pokkah boeng. Severe incidence of the pest was also observed in some farmers' fields with the popular variety Co 86032 (Figure 2). Both crop stunting due to mealybug infestation as well as crop recovery due to the application of control measures, usually an insecticide and sometimes by also applying a fungicide, could be noticed. In some fields, prophylactic insecticidal sprays protected the crops from pests.

Incidence and nature of infestation on a new host, Saccharum spontaneum

Based on the literature survey, it could be ascertained that *P. saccharifolii* had not been recorded earlier in Tamil Nadu

Table 1. Per cent incidence of *Phenacoccus saccharifolii* on *Saccharum spontaneum* collections at the ICAR-Sugarcane Breeding Institute, Coimbatore

Saccharum spontaneum clone	Number of plants	Affected plants	% Incidence	Grade
IND-21-2055	7	0	0.00	0
IND-21-2056	13	3	23.08	2
IND-21-2057	27	8	29.63	1
IND-21-2058	10	1	10.00	2
IND-21-2059	10	4	40.00	2
IND-21-2060	19	7	36.84	2
IND-21-2062	14	9	64.29	2
IND-21-2063	35	6	17.14	2
IND-21-2064	30	6	20.00	2
IND-21-2065	29	10	34.48	2
IND-21-2066	11	6	54.55	3
IND-21-2067	11	4	36.36	2
IND-21-2069	20	0	0.00	0
IND-21-2070	22	5	22.73	1
IND-21-2071	19	0	0.00	0
IND-21-2072	25	0	0.00	0
IND-21-2073	11	0	0.00	0
IND-21-2074	16	0	0.00	0
IND-21-2075	19	0	0.00	
IND-21-2076	15	0	0.00	0
IND-21-2077	19	0	0.00	0
IND-21-2078	12	0	0.00	0
IND-21-2079	17	5	29.41	1
IND-21-2080	16	5	31.25	2
IND-21-2081	32	0	0.00	0

Figure 3. *Phenacoccus saccharifolii* on *Saccharum spontaneum*, a wild relative of sugarcane.

in *Saccharum officinarum*, *S. spontaneum* or *Erianthus arundinaceus*. In this study, its infestation on *S. officinarum* cultivars as well as *S. spontaneum* clones could be confirmed in Tamil Nadu (Figure 3 and Table 1). Among the 25 genotypes of *S. spontaneum* observed, 11 were free from *P. saccharifolii* incidence.

The infestation ranged from nil to 64.29% (IND-21-2062), with a mean incidence of 17.99. Grading was found to be from nil to 3 (IND-21-2066), with an average of 1.18. Honeydew secretion was minimal and ant activity was nil. Parasitoid activity was sporadic. No incidence was observed on the *S. spontaneum* lines IND-21-2069, IND-21-2071, IND-21-2072, IND-21-2073, IND-21-2074, IND-21-2075, IND-21-2076, IND-21-2077, IND-21-2078 and IND-21-2081. Three clones of *E. arundinaceus* (IND-21-2061, IND-21-2608 and IND-21-2087), despite being in the vicinity of *S. officinarum* clones decimated by *P. saccharifolii* and low infestation on *S. spontaneum* clones, did not harbour the population.

It was interesting to note that there was no incidence of *P. saccharifolii* on *S. spontaneum* plants infested with other species of mealybugs. Further, unlike *S. officinarum* cultivars, no co-existence of other pests, viz. aphids was noticed. *P. saccharifolii* has been observed on *E. arundinaceus* in Andhra Pradesh, but could not be observed in the present study. To the best of our knowledge, there are no previous studies on the incidence of *P. saccharifolii* on *S. spontaneum.* There are only records of this pest on *E. arundinaceus*[23] and *Sorghum halepense*[24] as its hosts, other than sugarcane *S. officinarium*[25]. In India, it has been found in Andhra Pradesh[26], Bihar[24,25,27], Kartnataka[26], Madhya Pradesh[26], Delhi[26], Uttar Pradesh[28] and West Bengal[26]. *P. saccharifolii* has also been reported from Nepal[24] and Pakistan[26].

Observations on mealybug colony composition and description

Each colony had all the life stages with overlapping generations. The tubular ovisacs were long and loosely compressed. Microscopic examination revealed that the egg masses were embedded in mealy threads of the ovisacs (Figure 4 *a*). Fresh eggs were pale yellow and elongated (Figure 4 *b*). The eggs were laid in batches in the same ovisac

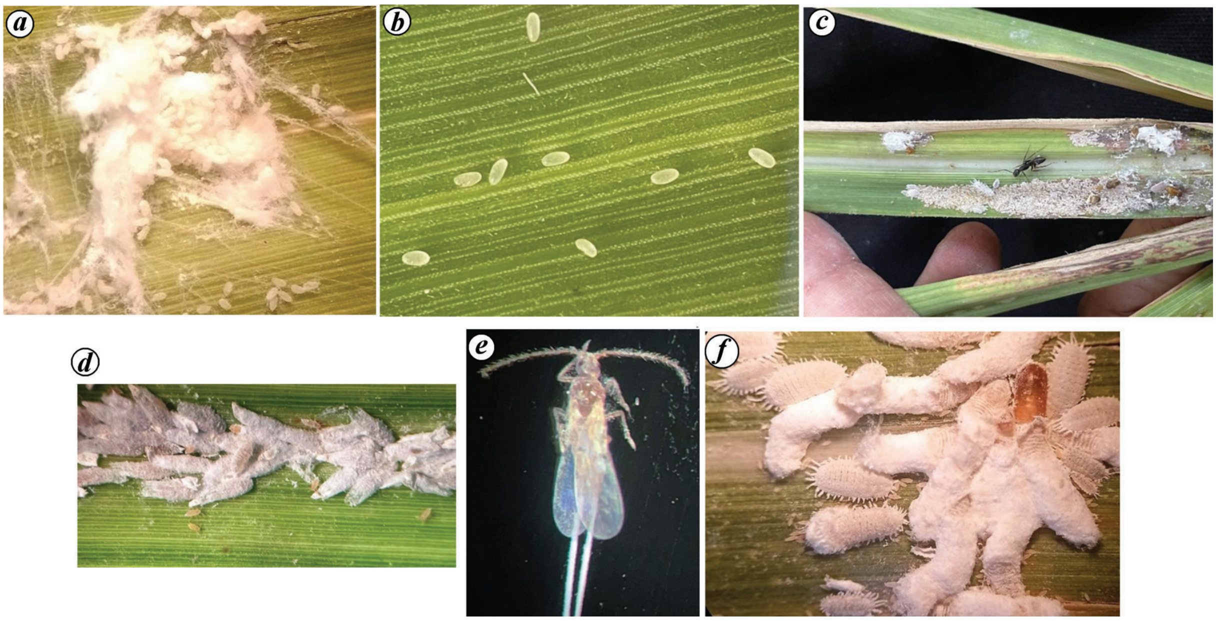

Figure 4. Different stages of the mealybug. ***a***, Eggs teased out of the ovisac. ***b***, Freshly laid eggs of crown mealybug. ***c***, Crawlers of *P. saccharifolii*. ***d***, Male cocoons. ***e***, Male adults. ***f***, Females with overlapping ovisacs.

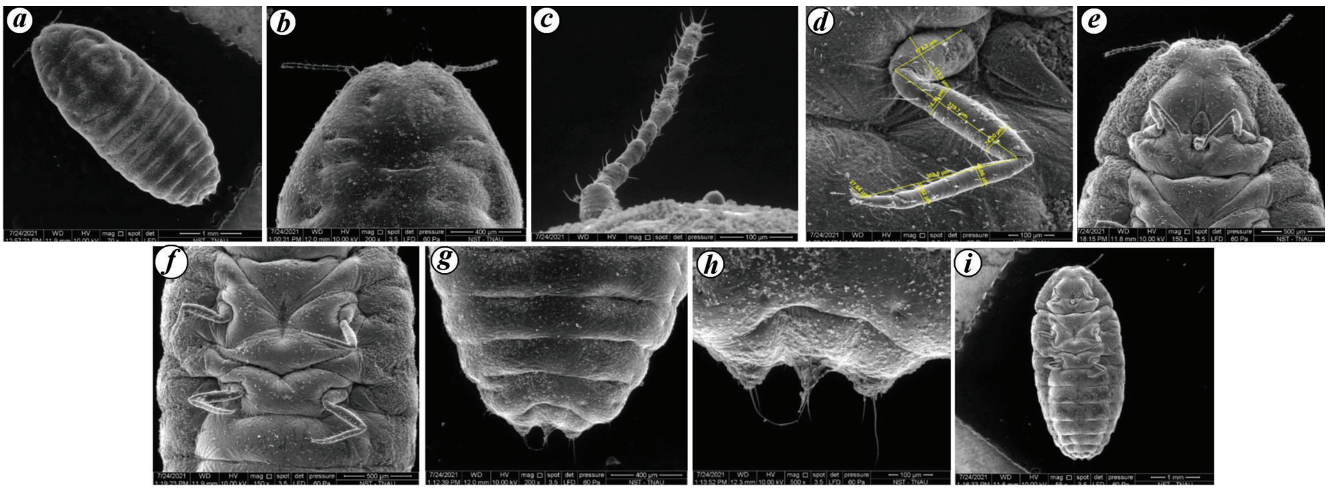

Figure 5. SEM photomicrographs showing the morphological features of the mealybug. ***a***, Whole body (dorsal side). ***b***, Anterior portion of the mealybug. ***c***, Antenna. ***d***, Close-up of leg. ***e***, Mouth parts. ***f***, Abdomen (ventral). ***g***, Posterior abdomen. ***h***, Caudal zone. ***i***, Whole body (ventral side).

as clusters (Figure 1 *e*). The prolifically emerging crawlers were yellow, highly active and moved in groups (Figure 4 *c*). Figures 5 and 6 reveal the morphological features. SEM revealed that the antennae were eight-segmented (Figure 5 *b* and 5 *c*). The legs were strong and well-segmented (Figure 5 *d*). The advanced nymphal instars were soft and yellow-bodied beneath the white mealy and powdery waxy coating (Figure 4 *f*). The waxy filaments were prominent all around the body, with protrusions along the flank more pronounced in males. Two pairs of long waxy filaments in the caudal region flanked by another pair of filaments were observed at the base of the abdomen. While males pass through a true pupal stage, the females moult into an adult without metamorphosis. Abundant tiny male cocoons arranged as pairs in overlapping rows in an inverted *V*-shape formed linear white festoons (microscopic view, Figure 4 *d*) along the vertical axis, mostly on the ventral side of the leaf, but on both sides of the leaf during an outbreak. The scurrying small and fragile adult males were found active during the day. Male adults possessed a pair of long white caudal filaments, and white translucent wings with a pinkish body (Figure 4 *e*).

The relatively inactive stout females heavily coated with mealy wax filaments formed the major part of a well-developed colony. The mature females spun ovisacs during the pre-ovipositional period of two days. Single or multiple mating was observed. Egg-laying was intermittent and in defined batches due to which the ovisac was extended (Figure 1 *c*).

In mature females, the ovisac grew linearly and often measured more than twice the size of its body (Figure 1 *c*). The ovisac covered the entire body, with only the head region protruding and exposed. The female body was slightly lifted at an angle with attachment to the leaf only by its mouth parts. The females often crowded together and overlapped their long ovisacs, resulting in a striking cotton-bed appearance (Figure 4 *f*). The long body of the female became globular, wide at the posterior end with the side projections of waxy filaments. The legs were prominent in all stages, but in mature females, they appeared to have shrunk in proportion to the swollen body. Feeding by females left a distinct black necrotic scars on the leaves (Figure 1 *f*).

Observations recorded in pot culture

Infestation occurred in most of the 650 potted plants. Leaf blades, leaf sheath and leaf whorls were found to harbour the pest in large numbers. In the field surveys, the infestation pattern was similar to that in pot experiments. The mature females, with their profuse mealy coating and long cottony ovisacs, were crowding prominently on the abaxial surface of the leaves. During an intense infestation, the population was found on the adaxial surface, mainly in the crown. The inner top portion of the leaf sheath at the leaf joint cupping the stem also harboured the pest. Young crawlers often reached the leaf whorl and congregated around the unopened leaf (–2) to settle down for feeding. The young nymphs then moved to the opened leaves and developed on the leaf blade under the protection of a mealy mesh of matured nymphs as well as adult females.

Crinkling, necrosis and rotting of +1 to +3 leaves were observed due to the high infestation of young plants (Figure 7 *a–d*). Further attack lead to rotting of up to –2 leaf. Desapped leaves turned pale orange, yellow and subsequently became dry. Due to feeding, necrotic spots or mottling developed on the leaves. As the population increased, the entire crown was affected; thus, the name crown mealybug. Intense attack on the leaf whorl led to rotting of the central culm and/or meristem, which is also known as dead heart. Loss of apical dominance induces tillering in young plants (tillering phase) or sprouting of aerial tillers in the case of a grand growth phase. Often, leaves of the new tillers, whether sprouted aerially or from the nodes at the ground level, were also infested and the whole sprouts withered away. The affected young plants seldom formed canes. Young crops, more specifically ratoons were vulnerable to this pest.

No recent reports of this mealybug are available in India or elsewhere. In isolated instances during 1919 and later in 1941, *P. saccharifolii* was common on sugarcane in North India[29,30] and later as a minor pest in a compilation[31]. The mealybug mainly attacked *E. arundinaceus* in South India, for example, Andhra Pradesh[30]. Ali[32] reported this mealybug to be a vector of spike disease of sugarcane caused by a virus, but later it was disproved. Perhaps the infestation of this mealybug had predisposed the plant to spike disease infection and thus may be indirectly associated with the disease. A similar situation was observed in Tamil Nadu, wherein the severely infested canes were frequently affected by pokkah boeng. The concurrence of the mealybug and pokkah boeng made plant recovery either slow or impossible.

It is rare to find a combination of sucking pests in the same niche in sugarcane. For example, whitefly (*Aleurolobus barodensis* Maskell) and woolly aphid (*Ceratovacuna lanigera* Zehntner) are not found together. The niche occupation can further be so specific in sugarcane that the two species of whitefly, viz. *A. barodensis* and *Neomaskellia bergii* (Signoret) do not occur together on the same leaf and on occasions in an ecosystem. A similar case of discrete site allocation is practised by the pink sugarcane mealybug *Saccharicoccus sacchari* (Cockerell) and the yellow mealybug *Kiritshenkella sacchari* (Green). Though they both occur on the sugarcane stalk, the former is found in the nodal region with the latter occupying the internodal region. However, as an isolated case, colonies of *P. sacchari* were frequently found to coexist with other sucking pests such as yellow sugarcane aphid, *Melanaphis sacchari* (Zehntner) (Figure 8), Giant scale *Icerya pilosa* Green, sugarcane whitefly *A. barodensis* and *Dysmicoccus carens* Williams in different ratios, with either the mealybug being predominant or the others.

The pot culture's population did not decline due to summer or monsoon rains. Perhaps the secured niche at the leaf

Figure 6. Slide-mounted adult female mealybug.

Figure 7. Symptoms of mealybug infestation and pokkah boeng. ***a***, Leaf blade harbouring a large number of mealybugs. ***b***, Mealybug infestation in the leaf whorl. ***c***, Necrosis, sooty mould and dead heart. ***d***, Symptom of mealybug infestation and pokkah boeng in young sugarcane plants.

Figure 8. Coexistence of *P. saccharifolii* with yellow aphid of sugarcane.

Figure 9. Crown mealybug – *Camponotus compressus* association in *Saccharum officinarium*.

whorl might protect the crawlers which help maintain the subsequent population levels. In general, extended dry rainless periods with clement weather favour mealybug infestation and the rainy season decimates the attack. However, *P. saccharifolii* multiplication was profuse during summer rainfall as well as the monsoon period. This has also been observed earlier by Ali[32].

On *S. officinarum* cultivars, profuse honeydew produced by the mealybugs due to continuous and gregarious feeding, patronized ants (Figure 9). The ant species observed were *Camponotus compressus* (Fabricius), *Anoplolepis longipes* Jerdon and *Monomorium aberrans* Forel, but mainly *C. compressus* which aided in the dispersal of the mealybug by physical transportation. Copious honeydew secretion also led to extensive growth of sooty mould *Capnodium* sp. mostly on the same leaves, unlike in the case of other sucking pests, wherein the leaves beneath the infested ones had the mould. When successive leaves were infested, the whole plant, specifically the crown, appeared dark and unhealthy due to heavy sooty mould development. However, honeydew secretion and sooty mould development were scarce in mealybug infestation on *S. spontaneum* clones. Ants were not observed, but the parasitoid activity was low. It is not known whether the dry abrasive texture of the *S. spontaneum* leaves or the relatively low population is the cause of the low level of parasitism (<15%), but even a single female or a young colony in *S. officinarum* could attract the ants.

The young mealybugs had a myrmecophilous ('ant-loving') association, which may be obligate myrmecophily (the mealybugs being constantly attended by a huge number of ants), or facultative myrmecophily (infrequently attended by a few ants), depending on the stage of the mealybugs or the species of ants. In the present study, while high attendance of ants was mostly observed, occasionally nuclear colonies of mealybugs were protected by the ant nests built to house them (Figure 10).

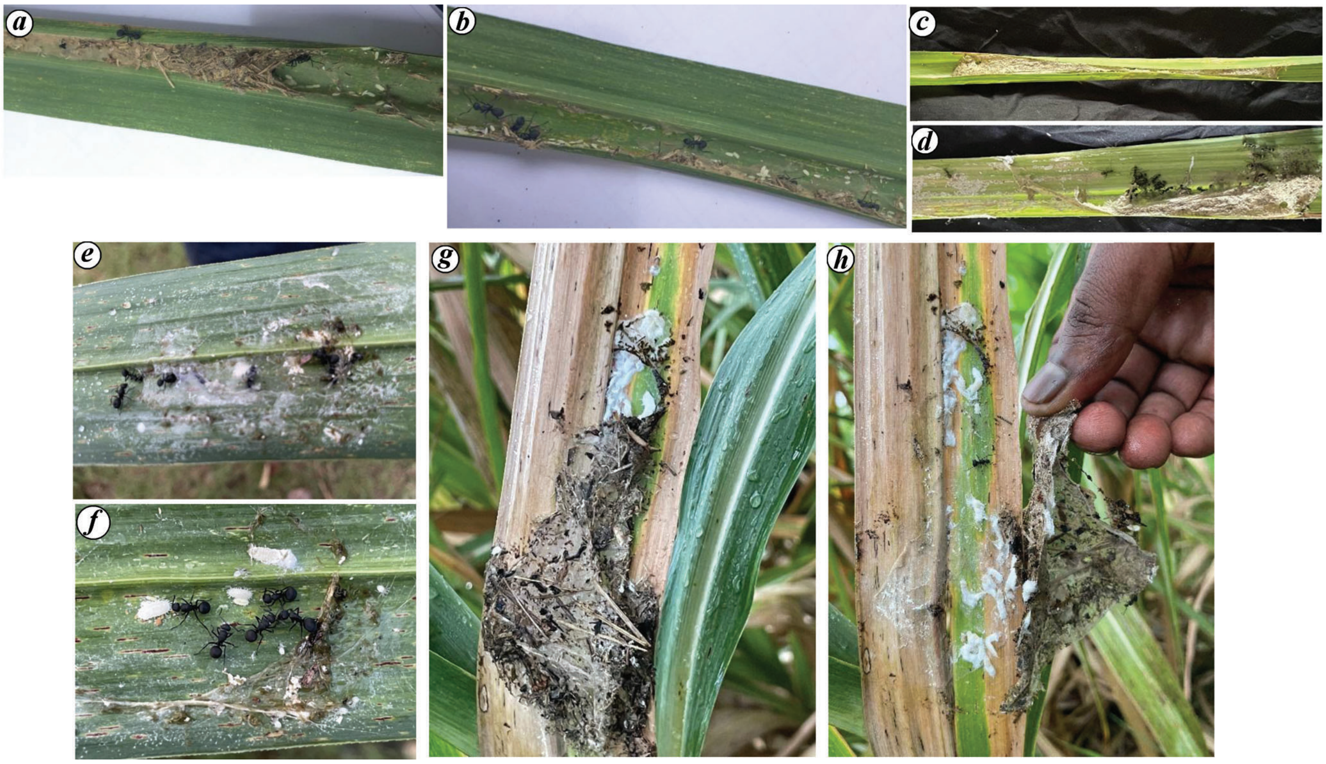

Figure 10. Ant nest for the protection of nuclear colony of *P. saccharifolii*.

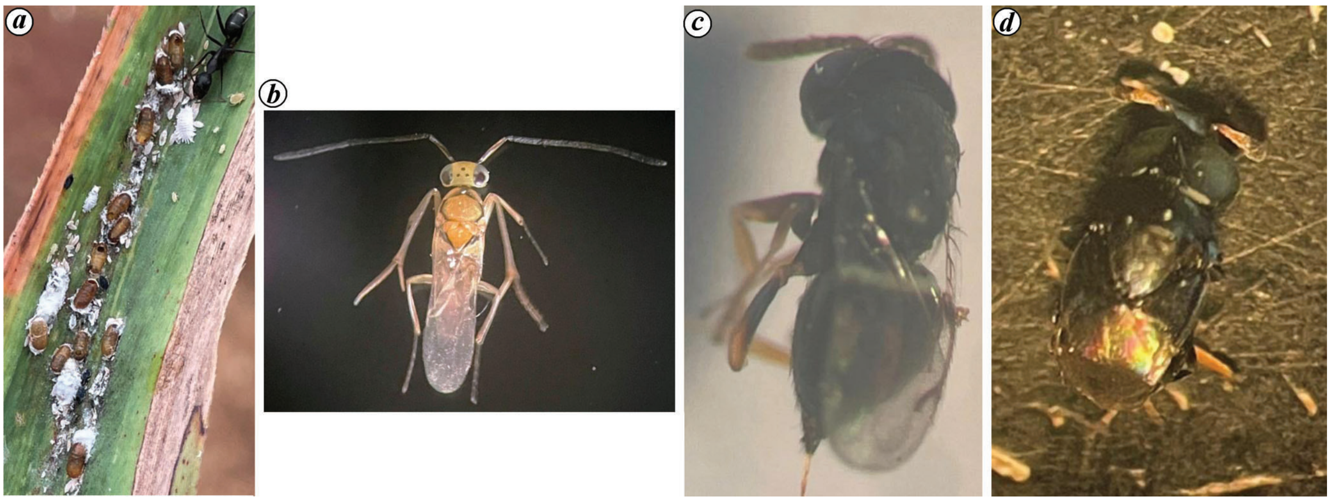

Figure 11. Parasitoids of *P. saccharifolii*. ***a***, Cocoons of parasitoids of *P. saccharifolii*. ***b***, *Leptomastix dactylopii*. ***c***, *Aenasius phenacocci*. ***d***, *Aenasius arizonensis*.

Ants also guarded the mealybugs by inferring with activity of predators and parasitoids. The most common predators were apefly *Spalgis epius* Westwood (Lepidoptera: Lycaenidae) and coccinellids *Scymnus nubilus* Mulsant and *Hyperaspis maindroni* Sicard. Three encyrtid endoparasitoids, viz. *Aenasius phenococci* (Ashmead), *Aenasius arizonensis* (Girault) and *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) were found to be highly active (Figure 11), but their activity peaked with a lag after the peak in the pest population. The natural enemies were active throughout the year (May 2021–June 2022) with the peak following a high mealybug population.

Ali[27] observed three coccinellid predators, viz. *Scymnus coccivora* Ramak, *Scymnus* sp. and *S. nubilus* Muls. on the eggs and nymphs of *P. saccharifolii* and two encyrtid parasitoids, viz. *Leptomastix* sp. and *Xanthoencyrtus* sp. on the nymphs and adults of the pest. Three encyrtid parasitoids, *A. phenacocci*, *Leptomastix ephyra* Noyes and Hayat, and

Leptomastix algirica Trjapitzin have been reported to be suitable for augmentative releases against another species of mealybug, *Phenacoccus solani* Ferris in Israel[33]. In India, several species of parasitoids and predators are highly active on other invasive species of *Phenococcus*[10–12].

Conclusion

In this study, we describe the crown mealybug *P. sacchari-folii* occurrence and infestation in devastating proportions on sugarcane in Tamil Nadu, though previous records of occurrence and sporadic outbreaks of this pest elsewhere in India six decades ago are available. Since then, till recently this pest has not been recorded in previously reported areas. Therefore, it is essential to constantly monitor the *P. saccharifolii* population as the homeostatic mechanisms to maintain the ecological or natural balance are yet to be attained by this pest. Hence outbreaks are to be expected and effective management measures must be followed on a war footing as the possibility of its immediate spread is imminent to virgin lands. Though there are no specific recommendations for use against this mealybug, curative or prophylactic application of chemicals that are currently being used for sucking pests provide the required population containment. Ratoons need additional surveillance, as they are intensely affected. As the wide spectrum of natural enemies active on this pest is common to the other species of this genus (*Phenacoccus*), there seems to be a possibility of shifting of natural enemy populations from other crops hosting any other species of *Phenacoccus*, specifically polyphagous ones such as *P. solenopsis*. Multiplication of these natural enemies for augmentation would mitigate the population asynchrony in the field between the natural enemies and the pest. *P. saccharifolii* infestation highlighted a novel scenario of increased severity of pokkah boeng and crop failure. Although the affected varieties suffered from pokkah boeng in the field, colonization of the insect in the spindle aggravated disease severity. Further studies are required on the physiological changes inflicted by combined damage due to the insect and the fungal pathogen.

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