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Occurrence of *Phenococcus solenopsis* (Tinsley) in vegetable ecosystem and host-mediated effects on its dominant parasitoid, *Aenasius bambawalei* Hayat

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Abstract

Phenacoccus solenopsis Tinsley was recorded as dominant mealy bug species in the vegetable ecosystem infesting several vegetables namely tomato, brinjal, *Capsicum*, okra and pointed gourd at IIVR experimental farm during 2011 to 2013. Its incidence was observed almost throughout the year on one or the other vegetable crops available in the region except during peak summer months of May and June. This mealy bug was observed to infest tomato during January to April; brinjal during March – April; pointed gourd during July- August and okra during July to October. From October to December, its incidence was documented on *Capsicum* grown mainly under poly- and net-house conditions. During peak summer (May-June), the incidence of *P. solenopsis* was restricted to weeds particularly *Parthenium hysterophorus*. Among different hosts, the highest cumulative recovery of parasitoid (*Aenasius bambawalei* Hayat, Encyrtidae: Hymenoptera) was obtained from tomato (35.67%) followed by okra (30.45%), whereas, the lowest recovery was from pointed gourd (13.33%) indicating tritrophic interactions among the vegetable host plant, mealy bug and its parasitoid.

Keywords: *Phenacoccus solenopsis,* endoparasitoid, vegetable ecosystem

Introduction

Solenopsis mealy bug, *Phenacoccus solenopsis* (Pseudococcidae: Hemiptera) was described originally from the United States in 1898 and it remained confined there until 1992 (Hanchinal, 2010) after which it spread to Central America, the Caribbean islands, Ecuador, Chile and Argentina (Williams *et al*, 1992; Ben-Dov, 2004; Larrain, 2002; Granara, 2003). During 2005, this mealy bug emerged as a serious sucking pest of cotton in Pakistan (Abbas *et al*, 2005; Hodgson *et al*, 2008). *P. solenopsis* is known to have been introduced from Pakistan into our country *via* the common borders that make both the countries extremely vulnerable to insect and disease transfers (Anonymous, 2006). Initially this pest was recorded on cotton crop in some districts of Punjab, but by 2007 it had spread throughout the major cotton growing districts and caused 30-40 per cent loss in cotton yield (Dhawan *et al.*, 2007). Subsequently, its serious incidence was reported across nine cotton growing states of the country, including Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, and Tamil Nadu during 2008-09 (Dharajyoti *et al*, 2008; Dhawan *et al*, 2008, 2009; Jhala and Bharpoda, 2008(a) (b); Suresh and Kavitha, 2008). Presently, this mealy bug has also been recorded in serious proportions on a number of solanaceous, malvaceous and cucurbitaceous vegetables, other agricultural crops and many weeds (Halder *et al.*, 2013). Among vegetables, serious infestations have been recorded in brinjal, okra, tomato, chilli, pumpkin, pointed gourd. Both nymphs and adults cause damage by sucking the sap from the growing points resulting in loss of vitality of the infested plants which ultimately dry. Black sooty mould also develops on their secretions which inhibits the photosynthetic activity of the plants. Information on seasonal incidence of *P. solenopsis* on different vegetables and the role of promising natural enemies are scanty. So, the present study focused on a survey for investigating the seasonal incidence of this mealy bug on different vegetables and associated weeds thorough out the year and host-plant mediated variations, if any, on its parasitisation by the encrytid, *Aenasius bambawalei* Hayat .

Materials and Methods

Occurrences of this invasive polyphagous mealy bug across various vegetable crops was studied throughout

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the year, along with its parasitoid in and around the experimental farm of Indian Institute of Vegetable Research (82°52¢ E longitude and 25°12¢ N latitude), Varanasi, Uttar Pradesh, India during 2011-13. Mealy bugs collected from infested plant parts (leaves, buds, twigs, branches, *etc.*) of different vegetables *viz*., brinjal (*Solanum melongena* Linn), okra (*Abelmoschus esculentus* L. Moench), tomato (*Solanaum lycopersicon*Linn.), cucurbits mainly pointed gourd (*Trichosanthes dioica* Roxb.) and pumpkin (*Cucurbita maxima* Duchesne), chillies and bell pepper (*Capsicum annuum* Linn.) were brought to the laboratory and preserved in 70% alcohol for its taxonomic identification. Further its period of incidence on various vegetable crops was also noted. Since these bugs were also observed on weeds which were identified as *Parthenium hysterophorus* and *Vernonia* sp, their period of incidence on them were also recorded.

Mealy bug infested 10-15 cm long twigs and buds from each of the host plants were collected randomly, brought to the Biocontrol Laboratory of Indian Institute Vegetable Research and placed in 250 ml glass conical flasks (Schott Duran) filled with water. A cotton swab was placed at the neck of the flask to prevent the mealy bugs from dropping into the water. These flasks were placed in cages sized 36 x 30 x 40 cm^3 and the number of mealy bugs on each twig were counted and examined for parasitisation, if any. The parasitoids emerging from these mealy bugs were collected and preserved in 70% alcohol for identification. The total number of adults and mummified female mealy bugs present on the twigs were counted and per cent parasitisation was calculated by the following formula:

$$\text{Per cent parasitisation} = \frac{\text{Number of mummified mealy bugs}}{\text{Total number of mealy bugs}} \times 100$$

Results and Discussion

Data recorded revealed that infestation by this mealy bug occurred almost through out the year on one or the other vegetable crops available in the region except during peak summer months of May and June. In tomato, this mealy bug infested the twigs, buds and leaves during winter season from January to April, whereas in brinjal serious infestation was recorded during its late reproductive stage i.e. during March – April particularly on leaves and buds (fig. 1). Similarly, in cucurbits like pointed gourd and pumpkin, its incidence appeared as white powdery cottony mass commonly attended by ants during July- August on growing points, buds and peduncle of the fruits. Another important vegetable of this area *i.e.,* okra was also infested by *P. solenopsis.* Infestation was recorded on mature fruits, buds and twigs during September to early November coinciding with the physiological maturity of the crop. From October to December, its incidence was recorded on chillies and bell peppers grown mainly in poly-houses and net-houses. During peak summer months of May and June, when very few vegetables are grown in this area, the incidence of *P. solenopsis* shifts to weeds particularly *Parthenium hysterophorus*. In addition to these, mealy bug incidence was also observed on another commonly growing weed *Vernonia* sp.

Parasitized mealy bugs can be easily identified by the presence of brown cocoons of the parasitoids sticking on the dorsal surface of their brown mummified host bodies. The identity of an endoparasitoid encountered in the present study was confirmed as *Aenasius bambawalei* Hayat (Encyrtidae: Hymenoptera) and diagnosed by the following taxonomic characters, *viz*., adult females small sized measuring 1.5 to 2mm long, body generally shiny black with bluish green metallic reflections; head with large setigerous punctures which are slightly less than the diameter of anterior ocellus; spaces between punctures narrow, reticulate with bronzy shine; punctures below eyes between malar space and scrobes and in the interantennal area mainly reddish bronze; pronotum, mesoscutum, axillae and scutellum dull metallic bluish green to blackish; propodeum distad of spiracles with some bluish-green shine; metasoma (gaster) dark brown with reflections of violet to bluish-green; antenna with radicle black; scape testaceus yellow with or without a brownish patch in the middle; pedicel, first and second funicular segments (F1 and F2) black; F3 dark brown, F4 pale brownish yellow; F5 and F6 testaceus yellow; clava variable dark brown to yellowish brown, basally brownish yellow; fore wings basally infuscate, distal half and costal cell hyaline; hind wings hyaline; legs black, except apices of all tibiae testaceus yellow to pale brown; fore and hind tarsi testaceus, last segment of hind tarsi brown; mid tarsi, especially basitarsus, pale yellow to nearly white; mid tibial spur white. Males smaller in size and differs from the female in the sculpture and colour of mesothoracic dorsum, antenna, fore wing venation and genitalia (Based on Hayat, 2009).

Observations recorded on host plant mediated effects on parasitisation of *P. solenopsis* by *A. bambawalei* based on the number of parasitoids emerging during indicated the highest cumulative parasitisation (35.67%) of *P. solenopsis* feeding on tomato followed by okra (30.45%) and chillies (20.67%), whereas the lowest

Month	Peak period of activity				
	Tomato	*Capsicum*	Brinjal	Cucurbits	Okra
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

Fig.1 Occurrence of *P. solenopsis* on different vegetables during various seasons

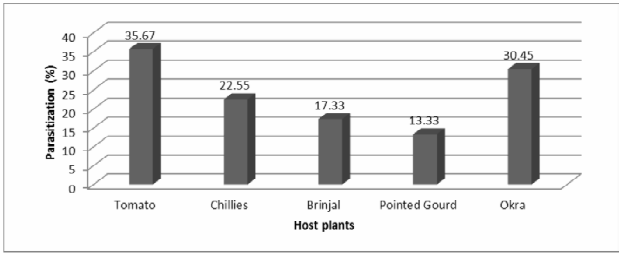

Fig.2 Host preference of *Aenasius bambawalei*, parasitoid of *Phenacoccus solenopsis* on different vegetables

was on pointed gourd (13.33%) followed by brinjal (17.33%) (fig. 2). Our present findings are in accordance with the earlier study made in Pakistan by Arif *et al.* (2012) who reported the highest parasitisation of mealy bug infesting tomato (72.7%) followed to that of okra (66.5%) and brinjal (36.4%). Host-mediated interactions are known to play a crucial role in the incidence of insect pests and their associated entomophagous insects. Biophysical and biochemical parameters of the host plants affect the distribution and abundance of the insect pests (Halder and Srinivasan, 2007 & 2011) thereby indirectly influence the flora and fauna feeding at the third trophic level. These variations in the population density of encyrtid parasitoid may be attributed to variation in the chemical nature of synomones emitted by different plant species damaged by *P. solenopsis*. Such synomones have not been investigated and are needed to be identified for manipulations in IPM programme for mealy bug control (Arif *et al*, 2012). In conclusion, since this invasive mealy bug occurred almost thorough out the year in one or other vegetables and weeds, so biointensive integrated management practices (BIPM) giving emphasis on the conservation of this parasitoid should be developed not only for ecofriendly management but also for sustainable vegetable production. Thus, from the present studies it is evident that *P. solenopsis* has become a major sucking pest in Varanasi across many vegetables almost throughout the year. During monsoon season, heavy rains may wash out this mealy bug leading to drop in its incidence. However, during the same period its population thrives well under poly- and net-house conditions. Since, the endoparasitoid *A. bambawalei* was found very promising in controlling this invasive mealy bug both in India and abroad so efforts should be directed towards developing the suitable technology for mass rearing of this parasitoid and further release in pest management programme. Similarly, future research must also be focused on development of insecticide tolerant strain of this bioagent.

Conclusion

The dominant mealy bug species in vegetable ecosystem was identified as *Phenacoccus solenopsis*. It was found to infest major vegetables namely tomato, brinjal, Capsicum, pointed gourd and okra. Almost thorough out the year, this mealy bug infested on one or other vegetable crops available in the region. The major endoparasitoid *viz., Aenasius bambawalei* of *P. solenopsis* was identified. Tritrophic interaction was elucidated based on the recovery of the parasitoids from different hosts. Since, this exotic, polyphagous mealy bug occurred almost throughout the year in the region, a biointensive pest management module (BIPM) emphasizing on conservation of this potent parasitoid should be developed for its ecofriendly management.

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सारांश

सब्जियों में मीली बग (*फेनेकोकस सालेनोप्सिस*) एक प्रबल प्रकोपकारी कीट है जो टमाटर, बैंगन, शिमला मिर्च, भिण्डी व परवल को प्रमुखता से नुकसान पहुँचाता है जैसा भा.कृ.अनु.प.– भारतीय सब्जी अनुसंधान संस्थान, वाराणसी के अध्ययन से स्पष्ट हुआ है। इसका प्रकोप अमूमन पूरे वर्ष मई व जून की भीषण गर्मी को छोड़कर एक फसल या दूसरे उपलब्ध फसल पर बना रहता है। यह मीली बग टमाटर को जनवरी से अप्रैल तक बैंगन को मार्च–अप्रैल, परवल को जुलाई – अगस्त तथा भिण्डी को जुलाई से अक्टूबर तक संक्रमित करता है। अक्टूबर से दिसम्बर इसका प्रकोप पाली हाऊस व नेट हाऊस में उग रहे शिमला मिर्च में भी देखने को मिलता है। भीषण ग्रीष्मकाल

(मई–जून) में इसका प्रकोप कुछ खरपतवारों जैसे पार्थेनियम हिस्टेरोफोरस तक सीमित हो जाता है। विभिन्न मेजमानों में सबसे ज्यादा परजीवी (ऐनासियस बाम्बावालेई ह्यात, इनक्रायटीडी; हिम्नोप्टेरा) की प्राप्ति टमाटर (35.67 प्रतिशत) हुई जो स्पष्ट करता है कि तीनो पौष्टिकता सम्बन्धी बातचीत, मिलीबग व इनके परजीवी सब्जियों पर होते है।

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