RECORD OF HOST PLANTS AND NATURAL ENEMIES OF SOLENOPSIS MEALYBUG, PHENACOCCUS SOLENOPSIS TINSLEY: A POTENTIAL PEST UNDER PROTECTED CULTIVATION IN HIMACHAL PRADESH

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ABSTRACT
Survey studies conducted in low hill regions of Himachal Pradesh to record the incidence and source of infestation of solenopsis mealybug Phenacoccus solenopsis Tinsley in the protected structures revealed 12 plant species belonging to 8 families comprising vegetables, ornamentals, weed and fruit and forest plants as the hosts to P. solenopsis. The incidence categorized in grade I-IV based on the severity of infestation revealed six plant species namely, Capsicum annuum Linn., Lantana camara Linn., Lycopersicon esculentum Mill., Malvastrum coromandelianum (L.) Garcke, Malaviscus penduliflorus DC. and Parthenium hysterophorus Linn. to be the preferred host. The others, Abelmoschus esculentus Linn., Achyranthes aspera Linn., Codiaeum variegatum (L.) A. Juss., Jatropha curcas Linn. and Mangifera indica Linn. were grouped in grade I-III with low to moderate incidence. Majority of the host plants recorded (66.7%) were situated on field peripheries, road sides and village paths and served as sources of infestation of solenopsis mealybug. Five coccinellid predators (Harmonia dimidiata Fabricius), Chilocorus nigrita (Fabricius), Coccinella septempunctata Linn., Harmonia dimidiata (Fabricius) and Oenopia sauzeti Mulsant) and one hymenopteran parasitoid (Aenasius arizonensis (Girault) (syn. A. bambawai/Hayat)) were found associated with P. solenopsis. All these constituted new record of the host plants and natural enemies of P. solenopsis from Himachal Pradesh.

INTRODUCTION
The solenopsis mealybug, Phenacoccus solenopsis Tinsley (Hemiptera: Pseudococcidae) an invasive species native to North America was noticed to appear on cotton crop in India during 2003-04 onwards (Jhala et al., 2008). It has emerged as serious pest of cotton and other crops in India (Nagrare et al., 2009; Bisane et al., 2010; Suresh et al., 2010; Siddhapara et al., 2013; Babu and Meghwal, 2014). The pest is polyphagous in nature with wide host adaptability in different climatic conditions (Patel et al., 2009; Joshi et al., 2010), hence facilitating spread and establishment on other crops of economic importance.

P. solenopsis is known for its high reproduction capacity producing 812 off-springs per female parthenogenetically with several generations in a year (Vennila et al., 2010). Its occurrence on a wide range of host plants (154 species) including field crops, vegetables, ornamentals, weeds, bushes and plants; most of these belong to the families Malvaceae, Solanaceae, Asteraceae, Euphorbiaceae, Amaranthaceae and Cucurbitaceae was documented by Arif et al. 2009. Mandal et al. (2014) recorded 65 host plant species in 24 families to be infested by P. solenopsis in West Bengal.

Himachal Pradesh is one of the leading states in protected cultivation of vegetable and flowers crops. Incidence of solenopsis mealybug was first recorded in Himachal Pradesh during 2012 under protected environment in regions bordering Punjab and Haryana states (Anonymous, 2013). The incidence and spread of this pest has increased in subsequent years. In this backdrop, the present study was conducted to record the host plants of P. solenopsis and mechanism of attainment of pest status by P. solenopsis.

MATERIALS AND METHODS
The studies were undertaken in Himachal Pradesh under open field and protected cultivation situations during 2013-14. Regular surveys were conducted to record the incidence of P. solenopsis on different plants. The infested host plants were categorized according to the plant type (fruit plants, ornamentals, trees, vegetables and weeds). Each recorded host was classified according to location of the host (field, road side, village path, field periphery etc.) and severity of infestation as suggested by Nagrare et al. (2012) as per following grades:

Grade I (G-I): about 1-10 mealybugs scattered over the plant;
Grade II (G-II): one branch infested heavily with mealybugs;
Grade III (G-III): two or more branches infested heavily with mealybugs, and up to 50% plant infested;
Grade IV (G-IV): plant infested severely with mealybugs, preferred host.
Apart from this, observations were also recorded on the associated natural enemies. For this, in situ observations were recorded on associated predators, whereas for recording the parasitoids, mummified mealybugs were brought to laboratory and kept for emergence of adults. The natural enemies were got identified from the experts.

RESULTS AND DISCUSSION

The survey studies undertaken in Himachal Pradesh revealed 12 plant species belonging to eight plant families to be the hosts to *P. solenopsis*. Maximum number of host plants belonged to family Malvaceae (3) followed by Solanaceae and Euphorbiaceae (2 each). The plant families namely, Amaranthaceae, Anacardiaceae, Asteraceae, Bombacaceae and Verbenaceae comprised one host plant each (Table 1). The hosts comprised three vegetable crops, two ornamental plants, four weeds and one each of fruit, shrub and forest tree. Based on severity of infestation, six plant species namely, *Capsicum annum* Linn., *Lantana camara* Linn., *Lycopersicon esculentum* Mill., *Malvastrum coromandelianum* (L.) Garcke, *Malvaviscus penduliflorus* (Linn.) A. Juss., *Jatropha curcas* Linn. and *Achyranthes aspera* Linn. were to G-III. The others, *Bombax ceiba* Linn., *Malvastrum coromandelianum* (L.) A. Juss., *Jatropha curcas* Linn. and *Mangifera indica* Linn. were graded G-I-II with low incidence.

Host plants recorded in present studies have also been recorded earlier from Punjab, Haryana, Rajasthan, West Bengal and Tamil Nadu by Suresh et al. (2010), Tanwar et al. (2011), Nagrare et al. (2012), Venkata et al. (2013), Babu and Meghwal, 2014, Mandal et al. (2014). The preferred host of *P. solenopsis* recorded in present studies were also observed by Nagrare et al. (2012) and Mandal et al. (2014) to be the hosts on which it was more abundant from different parts of India.

A perusal of Table 1 and Fig. 1 revealed most of the hosts (67%) of *P. solenopsis* were located on field peripheries, village paths and road side which are of importance for the survival and entry of *P. solenopsis* in protected structures. The weed hosts and wild vegetation constituted a major source of breeding place for *P. solenopsis*, which finds support from the work of Kumar et al. (2010) who recorded *P. solenopsis* to utilize weed hosts to the extent of 30.8 to 32.2 per cent.

Six natural enemies comprising five coccinellid predators and one parasitoid (Table 2) were observed associated with mealybug, *P. solenopsis* in Himachal Pradesh. Amongst predators, *Coccinella septempunctata* Linn. and *Cheilomenes sexmaculata* (Fabricius) were more abundant. One primary parasitoid, *Aenasius arizonensis* (Girault) (syn. A. bambawalei (Hayat)) and three hyperparasitoids were also recovered.

### Table 1: Host plants of *P. solenopsis* recorded in Himachal Pradesh

<table>
<thead>
<tr>
<th>Plant family</th>
<th>Common / Vernacular name</th>
<th>Scientific name</th>
<th>Category of plant</th>
<th>Infestation level</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthaceae</td>
<td>Puthkanda/ Prickly chaff flower</td>
<td><em>Achyranthes aspera</em> Linn.</td>
<td>Weed</td>
<td>G-III</td>
<td>Road side/ field periphery</td>
</tr>
<tr>
<td>Anacardiaceae</td>
<td>Mango</td>
<td><em>Mangifera indica</em> Linn.</td>
<td>Fruit tree</td>
<td>G-I</td>
<td>Road side</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Congress grass</td>
<td><em>Parthenium hysterophorus</em> Linn.</td>
<td>Weed</td>
<td>G-IV</td>
<td>Road side/ village paths</td>
</tr>
<tr>
<td>Bombacaceae</td>
<td>Semal/ Silk cotton tree</td>
<td><em>Bombax ceiba</em> Linn.</td>
<td>Forest tree</td>
<td>G-I</td>
<td>Road side</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Barbados nut</td>
<td><em>Jatropha curcas</em> Linn.</td>
<td>Ornamental</td>
<td>G-II</td>
<td>Home garden</td>
</tr>
<tr>
<td>Malvaceae</td>
<td>Sleeping hibiscus</td>
<td><em>Malvaviscus penduliflorus</em> DC.</td>
<td>Vegetable</td>
<td>G-III</td>
<td>Field</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Tomato</td>
<td><em>Lycopersicon esculentum</em> Mill.</td>
<td>Ornamental</td>
<td>G-IV</td>
<td>Road side</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Lantana</td>
<td><em>Lantana camara</em> Linn.</td>
<td>Vegetable</td>
<td>G-IV</td>
<td>Polyhouse</td>
</tr>
</tbody>
</table>

### Table 2: Natural enemies associated with *P. solenopsis* in Himachal Pradesh

<table>
<thead>
<tr>
<th>Natural enemy</th>
<th>Family</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predators</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cheilomenes sexmaculata</em> (Fabricius)</td>
<td>Coccinellidae</td>
<td>Coleoptera</td>
</tr>
<tr>
<td><em>Chilocorus nigrita</em> (Fabricius)</td>
<td>Coccinellidae</td>
<td>Coleoptera</td>
</tr>
<tr>
<td><em>Coccinella septempunctata</em> Linn.</td>
<td>Coccinellidae</td>
<td>Coleoptera</td>
</tr>
<tr>
<td><em>Harmonia dimidiata</em> (Fabricius)</td>
<td>Coccinellidae</td>
<td>Coleoptera</td>
</tr>
<tr>
<td><em>Oenopia sauzeti</em> Mulsant</td>
<td>Coccinellidae</td>
<td>Coleoptera</td>
</tr>
<tr>
<td>Parasitoids</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aenasius arizonensis</em> (Girault) (syn. A. bambawalei Hayat)</td>
<td>Encyrtidae</td>
<td>Hymenoptera</td>
</tr>
<tr>
<td>Hyperparasitoids of <em>A. arizonensis</em></td>
<td>Encyrtidae</td>
<td>Hymenoptera</td>
</tr>
<tr>
<td><em>Homalotylus sp.</em></td>
<td>Eriaporidae</td>
<td>Hymenoptera</td>
</tr>
<tr>
<td><em>Prochiloneurus sp.</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Myiocnema comperei</em> Ashmead</td>
<td>Encyrtidae</td>
<td>Hymenoptera</td>
</tr>
</tbody>
</table>
Fallahzadeh et al., 2014 considered A. bambawalei to be the junior synonym of A. arizonensis. The most abundant and dominant hyperparasitoid was Myiognema comperei Ashmead while the others were less abundant. A. bambawalei was accidentally introduced in India along with its host i.e. P. solenopsis (Fand et al., 2013). Pala Ram and Saini (2010) recovered four hyperparasitoids associated with A. bambawalei amongst them M. comperei was the most abundant and dominant species, which is also in line to present investigation. A. arizonensis (bambawalei) and its hyperparasitoids recorded in present studies were also reported earlier by Sankar et al. (2011) and Tanwar et al. (2011). Present investigation is supported by the studies of Kedar et al. (2011) and Arif et al. (2012) who observed natural enemies namely, C. septempunctata and C. sexmaculata associated with P. solenopsis.

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REFERENCES


