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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, *Malvaviscus penduliflorus* DC. and *Parthenium hysterophorus* Linn. to be the preferred host. The others, *Abelmoschus esculentus* Linn., *Achyranthes aspera* Linn., *Bombax ceiba* 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. bambawalei* 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 alien 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 annuum* Linn., *Lantana camara* Linn., *Lycopersicon esculentum* Mill., *Malvastrum coromandelianum* (L.) Garcke, *Malvaviscus penduliflorus* DC. and *Parthenium hysterophorus* Linn. were observed to bear G-IV infestation and were categorised as preferred hosts.Two plants namely, *Abelmoschus esculentus* Linn. and *Achyranthes aspera* Linn. were to G-III. The others, *Bombax ceiba* Linn., *Codiaeum variegatum* (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), Vennila *et al.* (2013), Babu and Meghwal, 2014, Mandal *et al.* (2014). The preferred hostsof *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

Plant family	Common / Vernacular name	Scientific name	Category of plant	Infestation level	Location
Amaranthaceae	Puthkanda/ Prickly chaff flower	*Achyranthes aspera* Linn.	Weed	G-III	Road side/ field periphery
Anacardiaceae	Mango	*Mangifera indica* Linn.	Fruit tree	G-I	Road side
Asteraceae	Congress grass	*Parthenium hysterophorus* Linn.	Weed	G-IV	Road side/ village paths
Bombacaceae	Semal/ Silk cotton tree	*Bombax ceiba* Linn.	Forest Tree	G-I	Road side
Euphorbiaceae	Croton	*Codiaeum variegatum* (Linn.) A. Juss	Ornamental	G-II	Home garden
	Barbados nut	*Jatropha curcas* Linn.	Shrub	G-II	Field periphery/ village paths
Malvaceae	Bhendi/ Okra	*Abelmoschus esculentus* Linn.	Vegetable	G-III	Field
	False mallow/ Broom weed	*Malvastrum coromandelianum* (Linn.) Garcke	Weed	G-IV	Field periphery
	Sleeping hibiscus	*Malvaviscus penduliflorus* DC.	Ornamental	G-IV	Road side
Solanaceae	Tomato	*Lycopersicon esculentum* Mill.	Vegetable	G-IV	Polyhouse
	Capsicum	*Capsicum annuum* Linn.	Vegetable	G-IV	Polyhouse
Verbenaceae	Lantana	*Lantana camara* Linn.	Weed	G-IV	Road side/ field periphery

Table 2: Natural enemies associatedwith*P.solenopsis* in Himachal Pradesh

Natural enemy	Family	Order
Predators		
Cheilomenes sexmaculata (Fabricius)	Coccinellidae	Coleoptera
Chilocorus nigrita (Fabricius)	Coccinellidae	Coleoptera
Coccinella septempunctata Linn.	Coccinellidae	Coleoptera
Harmonia dimidiata (Fabricius)	Coccinellidae	Coleoptera
Oenopia sauzeti Mulsant	Coccinellidae	Coleoptera
Parasitoids		
Aenasius arizonensis (Girault) (syn. *A. bambawalei* Hayat)	Encyrtidae	Hymenoptera
Hyperparasitoids of *A.arizonensis*		
Homalotylus sp.	Encyrtidae	Hymenoptera
Prochiloneurus sp.	Eriaporidae	Hymenoptera
Myiocnema comperei Ashmead	Encyrtidae	Hymenoptera

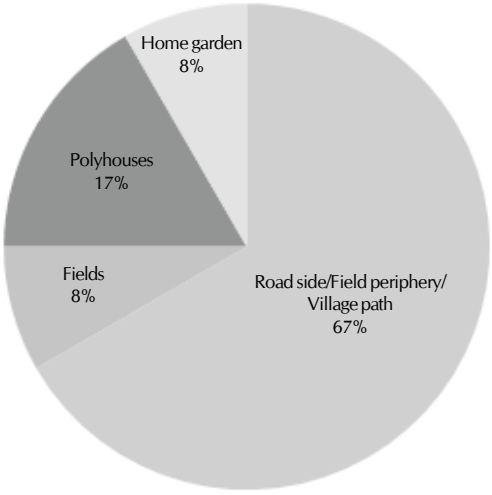

Figure 1: Location of mealybug host plants

Fallahzadeh *et al.,* 2014 considered *A. bambawalei* to be the junior synonym of *A. arizonensis*. The most abundant and dominant hyperparasitoid was *Myiocnema comperei* Ashmead while the others were less abundant.

A. bambawalei was accidentally introduced in India alongwith 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 such as *A. arizonensis* (*bambawalei*) and coccinellids namely, *C. septempunctata* and *C. sexmaculata* associated with *P. solenopsis*.

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