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Survey of Host Plants of Cotton Mealybug *Phenacoccus solenopsis* Tinsley (Homoptera: Pseudococcidae) on Cotton Crops in Middle Awash, Ethiopia

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ABSTRACT

The exotic cotton mealybug *Phenacoccus solenopsis* Tinsley invaded Ethiopia during 2010, and caused widespread infestation across all six cotton growing regions. This New World species has emerged as a serious pest of cotton and other crops and weeds. Forty two host plants of *P. solenopsis* were identified during the cotton growing season. The host plants of *P. solenopsis* revealed 42, 31, and 30 species of plants belonging to 21, 16 and 16 families served as hosts for *P. solenopsis* at Werer, Melka Sedi, and Gewane and across all cotton growing areas of Middle Awash, respectively. The trend of *P. solenopsis* severity among host plants across growing areas was clearly different although G4 plants were the highest at all growing areas. This information can be helpful in management of this pest.

INTRODUCTION

Cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) is a soft-bodied insect that sucks sap from the host plant phloem tissues, removing biomass and water (Aijun *et al*., 2004). The attacked cotton plants remain stunted and produce fewer bolls of a smaller size; leaves become distorted, yellow and eventually drop off (Mark & Gullan, 2005). After feeding, the insect ejects honeydew resulting in sooty mold growth that fouls plant surfaces, blocks stomata, so impeding respiration and photosynthesis, and hence reduce yield (Saeed *et al.,* 2007). About 5000 species of mealy bug have been recorded from 246 families of plants throughout the world. Among these, 56 species have been reported from 15 genera of family Malvaceae,

including cotton and many other plants of economic importance (Ben-Dov, 1994). In Ethiopia, Cotton mealybug appeared in Melka Sadi locality in July 2010. In this year the infestation was at isolated spots and the damage the pest inflicted was insignificant. In 2011, however, the pest heavily infested wide areas of cotton fields in different localities of Awash Valley.

At present, *P. solenopsis* is the only major mealy bug species found infesting cotton in all the cotton growing areas of Ethiopia. Through an extensive survey that covered the whole cotton growing places in the country, the cotton mealy bug was found to be very well established from Tibila (Oromia) to Afambo (Afar) in the Awash River Basin. It was also introduced into rain fed cotton growing areas in the Amhara, Gambella, SNNPS, and Tigray regions and irrigated cotton in SNNPS (Bayeh and Meisso, 2013) and escalation of severe damage caused by this pest to one of the most important cash crops in Ethiopia, called for immediate action. As the pest was invading fast in newer areas, furthermore, there was an urgent need to collect information on its distribution, infestation and natural enemies in different cotton growing areas that would help in formulating the management strategy for this species. Therefore, this survey was conducted for identification; to determine plant category and severity level of cotton mealy bug on the different host plants from cotton-growing areas of Werer, Melka Sedi and Gewane in Middle Awash, Ethiopia.

MATERIALS AND METHODS

These studies were carried out from year 2013 to 2014 through fortnightly surveys in three representative cotton growing areas of Middle Awash *viz*., Werer, Melka Sedi and Gewane. The cotton cultivation at Middle Awash was completely under irrigation. All production areas had largely 100 percent cultivated Delta Pine 90 variety. Weed hosts in the cotton ecosystem harboring *P. solenopsis* were located. At each specific locality, three cotton fields located at the entrance to the farm, in the middle ground and at the end were selected in a diagonal way and one hectares of each field were sampled. For each hectare, about 10 sample plants were randomly selected for cotton mealybug assessment by diagonal cotton fields. Then, severity of infestation by cotton mealybug was scored. Severity of infestation was measured using zero to four scale viz. (Anon., 2008), Grade 0(G0) – no mealybug; Grade 1(G1) – scattered appearance of few mealy bugs on the plant; Grade 2(G2) – severe incidence of mealybug on any one branch of the plant; Grade 3(G3) – severe incidence of mealybug on more than one branch or half portion of the plant and Grade 4(G4)– severe incidence of mealy bug on the whole plant. The weed plants were also collected and preserved as herbarium to confirm their botanical identity from Addis Ababa University, College of Biology. The host-plant species studied were identified, listed; the infested parts of each host plants. The number of plants found hosting *P. solenopsis* among cotton growing areas, their distribution across plant families and severity of weeds and locations were recorded.

RESULTS AND DISCUSSION

Host Plants

The results of this study have been summarized in one table (Table 1 below). Table 1 shows the list of host plants species in alphabetical order of families, plant species in order of plant category and grading of severity level on host plants throughout the season conducted during the observation of the CMB in the field from 2013 to 2014.

In the present study, a total of 42 host-plants in 21 families are reported. *P. solenopsis* has been recorded on members of 31 major plant genera in 13 families (Ben-Dov *et al.,* 2008), these results are in accordance with the present study**.** The diversity of host plants observed during the surveys reflected the preferences of the CMB in natural conditions. *Amaranthus dubius Mart. ex Thell., Amaranthus viridis L., Parthenium hysterophorus L., Xanthium strumarium L., Spathodea campanulata P. Beauv., Acalypha indica L., Abelmoschus esculentus L., Abutilon indicum L. Sweet, Gossipium barbadense L.*, *Gossipium hirsutum L., Sida alba L., Sesamum indicum L., Datura stramonium L., Solanum incanum L. and Corchorus trilocularis L.* were preferred host plants.

Table 1. List of host plant species in alphabetical order of families, Plant Category and Severity.

S. No	English Name	Scientific Name	Plant category	Severity Werer		M. sedi	Gewane
1	**Acanthaceae**	Velvet bushwilow	*Justicia nyassana Lindau*	Weed	***		
2	**Acanthaceae**	Ruellia	*Ruellia patula Jacq.*	Weed	**	**	**
3	**Aizoaceae**	Desert horsepurslane	*Trianthema portulacastrum L.*	Weed	***	***	***
4	**Aizoaceae**	Red Spinach	*Trianthema triquetra Willd.*	Weed	**	**	**
5	**Aizoaceae**		*Zaleya Pentandra (L.) Jeffery*	Weed	***	***	***
6	**Amaranthaceae**	Devils horse whip	*Achyranthes aspera L.*	Weed	***	**	**
7	**Amaranthaceae**	Pig weed	*Amaranthus dubius Mart. ex Thell.*	Weed	****	****	****
8	**Amaranthaceae**	Pig weed	*Amaranthus viridis L.*	Weed	****	****	****
9	**Apocynaceae**	Rubber vine	*Cryptostegia grandiflora R. Br.*	Weed	**	**	**
10	**Asclepiadaceae**	Gun powder bush	*Calotropis procera (Ait.) Ait. F.*	Weed	*	*	*
11	**Asteraceae**	Wild lattuce	*Launaea cornuta (Oliv. & Hiern.) C. Jeffrey*	Weed	**	**	**
12	**Asteraceae**	Parthenium	*Parthenium hysterophorus L.*	Weed	****	****	****
13	**Asteraceae**	Vernonia	*Vernonia galamensis (cass.) Less.*	Medicinal	**		
14	**Asteraceae**	Cocklebur	*Xanthium strumarium L.*	Weed	****	****	****
15	**Bignoniaceae**	Fountain Tree	*Spathodea campanulata P. Beauv.*	Tree	****		
16	**Capparidaceae**	Spider flower	*Gynandropsis gynandra*	Weed	**	**	**
17	**Convolvulaceae**	Sweet Potato	*Ipomoea batatas (L.) Lam.*	Vegetable	***		
18	**Cucurbitaceae**	Wild Pumpkin	*Cucumis dipsaceus Ehrnb. ex spach.*	Weed	**	**	**
19	**Cucurbitaceae**	Pumpkin	*Cucurbita pepo L.*	Vegetable	**		
20	**Euphorbiaceae**	Indian acalypha	*Acalypha indica L.*	Weed	****	****	****
21	**Euphorbiaceae**	Asthma Plant	*Euphorbia hirta L.*	Weed	***	***	***
22	**Fabaceae**	Alysicarpus	Alysicarpus quartinianus A. Rich.	Weed	**	**	**
23	**Fabaceae**	Indigo	*Indigofera coerulea Roxb.*	Weed	**	**	***
24	**Fabaceae**	Lead tree	*Leucaena leucocephala L.*	Tree	**		
25	**Fabaceae**	Madras thorn	*Pithecellobium dulce (Roxb.) Benth.*	Tree	*	*	
26	**Fabaceae**	Mequite	*Prosopis juliflora (sw.) DC.*	Tree	**	**	**
27	**Fabaceae**	Least snout-bean	*Rhynchosia minima (L.) DC.*	Weed	**	**	**
28	**Malvaceae**	Okra	*Abelmoschus esculentus L.*	Vegetable	****		
29	**Malvaceae**	Indian mallow	*Abutilon indicumL. Sweet.*	Weed	****	****	****
30	**Malvaceae**	Egyptian cotton	*Gossipium barbadense L.*	Crop	****		
31	**Malvaceae**	American Cotton	*Gossipium hirsutum L.*	Crop	****	****	****
32	**Malvaceae**	Paddy's lucerne	*Sida alba L.*	Weed	****		
33	**Nyctaginaceae**	Tar-vine	*Boerhaavia ercta L.*	Weed	***		

Table 1. **Contd….**

S. No	Family	English Name	Scientific Name	Plant category	Severity		
					Werer	M. sedi	Gewane
34	**Palmeae**	Date palm	*Phoenix dactylifera L.*	Fruit Crop	*		
35	**Pedaliaceae**	Sesame	*Sesamum indicum L.*	Crop	****		
36	**Portulacaceae**	Purslane	*Portulaca oleracea L.*	Weed	***		
37	**Rutaceae**	Lemon	*Citrus limon L.*	Fruit Tree	**		
38	**Solanaceae**	Thorn apple	*Datura stramonium L.*	Weed	****	****	****
39	**Solanaceae**	Tomato	*Lycopersicum esculentum (L.) Mill.*	Vegetable	***		
40	**Solanaceae**	Sodom apple	*Solanum incanum L.*	Weed	****	****	****
41	**Tiliaceae**	Humera Weed	*Corchorus trilocularis L.*	Weed	****	****	****
42	**Zygophyllaceae**	Puncture Vine	*Tribulus terrestris L.*	Weed	**	**	**

Severity: *=G1 **=G2 *=G3 ****=G4**

Host plant categories

Largest number of hosts of *P. solenopsis* was from weeds (28) followed by trees (4), vegetables (4), field crops (3), Fruit plants (2) and medicinal plant (1) also served as hosts of *P. solenopsis* in Middle Awash which results similar with in coastal region of West Benga by (Patel *et al*.,2011). The order of hosts of *P. solenopsis* across plant categories at Werer, Melka Sedi and Gewane cotton growing areas were similar, with weeds occupying the top position. Fruit plants and medicinal plant in their decreasing order represented the lower end of host spectrum (Table 1 above). The spread of host range largely across weeds, trees and vegetables over field crops indicate the priority of monitoring and management of *P. solenopsis* on these categories of plants in the cotton production system across growing areas.

Host records

Forty two, 31, and 30 species of plants belonging to 21, 16 and 16 families served as hosts for *P. solenopsis* at Werer, Melka Sedi, and Gewane and across all cotton growing areas of Middle Awash, respectively (Table 1 above). Vennila *et al.* (2011) reported that 71, 141, 124 and 194 species of plants belonging to 27, 45, 43 and 50 families served as hosts for *P. solenopsis* at North, Central, and South and across all cotton growing zones of India, respectively. Weed hosts constituted 66.67, 64.26 and 64.26 per cent in respect of Werer, Melka Sedi, and Gewane. Out of the total 42 hosts of *P. solenopsis* documented across the Middle Awash, 66.67 % were weeds (Fig. 1).

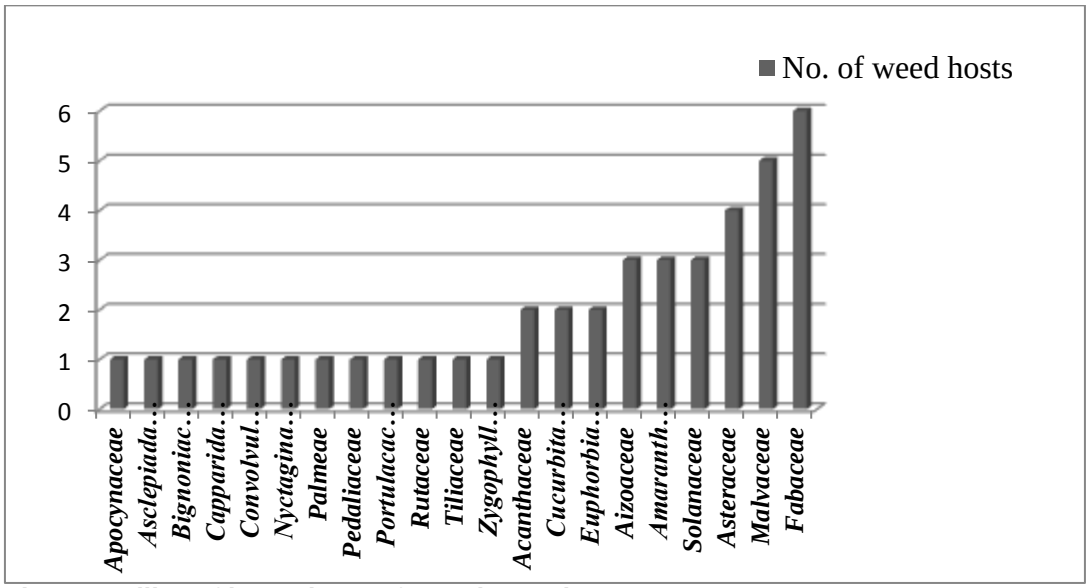

Fig.1. Families of host plants of *P. solenopsis*

Diversity of weed hosts

A total of 42 plant species from 21 different plant families served as hosts of *P. solenopsis* in Middle Awash which results were 13 plant species lower than those recorded in Pakistan by (Abbas *et al*., 2010). The diversity of hosts for *P. solenopsis* was greater at Werer (100%) followed by Melka Sedi (73.81%) and Gewane (71.43%) cotton growing areas. While common hosts were minimal between Werer + Melka Sedi (31) and Werer + Gewane (30) cotton growing areas, the highest commonality was observed between Werer + Melka Sedi (31) cotton growing areas. One monocot host plant *Phoenix dactylifera L.* was the only common hosts between Werer + Gewane and one medicinal plant in Werer research field **(**Table 2 above).

Highest number of weed hosts of *P. solenopsis* belonged to Fabaceae (6) > Malvaceae (5) > Asteraceae (4) > Aizoaceae= Amaranthaceae= Solanaceae (3) > Acanthaceae= Cucurbitaceae= Euphorbiaceae (2). Twelve families had single weed species as host plants for *P. solenopsis* (Fig.2).

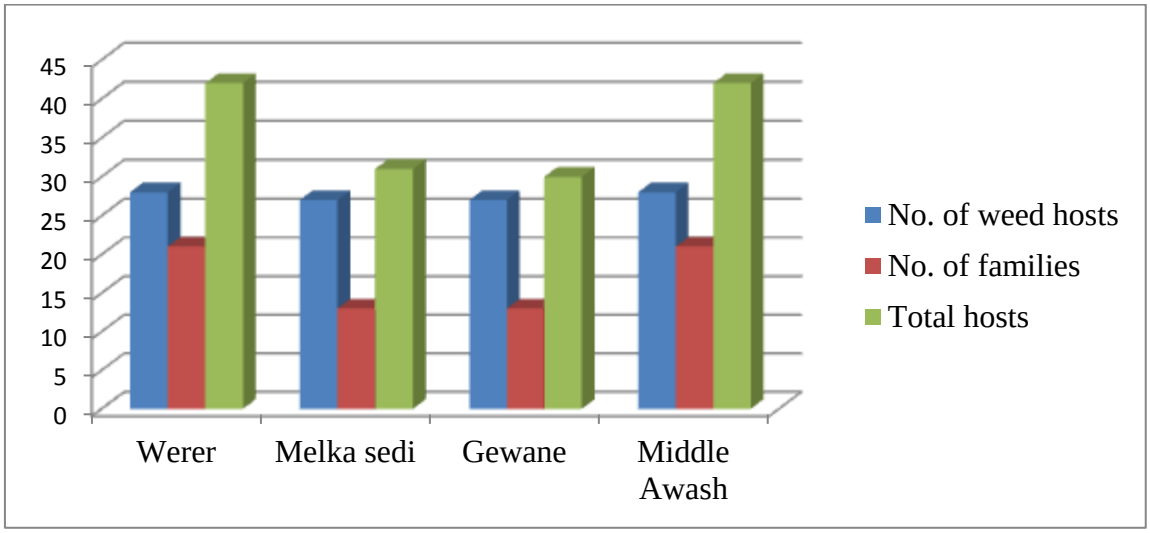

Fig. 2. Distribution of host plants of *P. solenopsis*

Severity of *P. solenopsis* on host plants

The trend of *P. solenopsis* severity among host plants across growing areas was clearly different although G4 plants were the highest at all growing areas. More number of Grade 4 hosts at all three growing areas indicated their possible role in carryover than perpetuation of *P. solenopsis*. The host plants with extreme severity (G4) in order of importance were: Werer >Melka Sedi >Gewane and a total of 15 (35.71%)

hosts had G4 severity among the total host plants documented for the country (Table 2). Twenty eight, 19, 14 and 23 host plants represented 34, 27, 12 and 27% of *P. solenopsis* severity with Grade 1, Grade 2, Grade 3 and Grade 4, respectively. These results are similar with the study of Vennila *et al*.(2010).

Table 2. Severity of *P. solenopsis* among hosts plants

S. No.	severity	Cotton growing area			Middle Awash
		Werer	Melka Sedi	Gewane	
1	Grade 1 (G1)	3	2	2	3
2	Grade 2 (G2)	15	11	12	15
3	Grade 3 (G3)	9	4	5	9
4	Grade 4 (G4)	15	14	11	15
	Total	42	31	30	42

CONCLUSIONS

It may be concluded that effective weed control, biological control, chemical control, field sanitation, following proper crop rotation and quarantine measures will be of high significance while adopting management strategy of this cotton mealybug.

It should be emphasized that this work was done at three locations (Werer, Melka Sedi and Gewane) at Middle Awash in a single year and a limited number of host plants of cotton mealybug *Phenacoccus solenops* in some of these results may differ under more intensive study from year-to –year and location-to-location of all cotton growing areas, to advance the recommendation and useful information for developing effective and efficient pest management technologies for cotton mealybug *Phenacoccus solenopsis* (Tinsley).

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