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Host plant range of mealybug *Phenacoccus solenopsis* Tinsley and its migration study

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Abstract

Phenacoccus solenopsis Tinsley (Hemiptera: Pseudococcidae) is an invasive pest which threatening cotton cultivation. To know the host range and its migration throughout the year field studies carried out from year 2014 to 2017 at cotton fields, field borders, roadside, water channel and gardens in Jalna district. The observation of host plant recorded as 0-4 grade scale.

The result of these studies reveals that total 51 plant species observed as host which belongs to 15 plant families including field crops, vegetables, ornamentals, medicinal and weeds. The order of importance of hosts of *P. solenopsis* from the documented families was Malvaceae > Solanaceae > Astaraceae > Euphorbiaceae > Amaranthaceae > Portulacaceae. Cotton mealybug observed to survive on *Parthenium hysterophorus*, *Datura metel*, *Trienthera portulacastrum*, during summer/ offseason and on *Hibiscus rosa-sinensis*, *Abutilon indicum*, *Withania somnifera* throughout the year. In present study one new plant species *Corchorus olitorius* (Malvaceae) observed to be new host of cotton mealybug. During offseason mealybug was reported in stacks of infested cotton stalks and weed host survived in winter & summer season, after arrival of favorable condition carryover this pest to neighboring host and migrates to cotton. The integrated management of alternate host plants specially weeds located along roadside, field borders and within fields will help to suppress the pest if practiced regularly.

Keywords: mealybug, *Phenacoccus solenopsis*, host plant, species, survey, migration & jalna

1. Introduction

Phenacoccus solenopsis Tinsley (Hemiptera: Pseudococcidae) is an invasive species threatening cotton cultivation in India and all over the world. It is observed in 35 localities among globe Ben-Dov 2009 [6]. *P. solenopsis* is soft bodied, oval shaped insect pest covered with whitish cottony mealy wax. It sucks plants sap by inserting its stylet in plant tissues of leaves, shoot apex and cause yellowish, curling of leaves and deformation of infested part, it causes premature leaf, flower and fruit drop beside this it secretes honey dew which enhances the development of the black sooty mould and finally the death of plant Culik MP, Gullan PJ [8].

Due to wide host range, large cotton area, high reproductive potential and ability to adjust in all climatic condition *P. solenopsis* known as major pest status on preferred host of cotton Tanwar *et al.* [20]. This pest first observed in Texas, USA on cotton cultivation field Fuch *et al.* [11]. Further it spread to several countries Brazil, Chile, and China [22, 3, 4]. It caused losses to cotton crops in Pakistan and India [1, 17]. It is highly polyphagous damaging over 203 plant species which belongs to 56 plant families across globe Ben-Dov *et al.* 2015 [7]. *P. solenopsis* has wide host range which includes field crops, vegetables, ornamental, fruit crop and weeds further he reported 104 weeds from 38 plant families Vennila *et al.* [21].

Cotton mealybug caused 30-60% yield losses in cotton during 2005-09 in India and Pakistan [9, 13, 17]. In the cotton producing belt of Pakistan (totaling 323485 ha in Punjab and Sindh), over 60700 ha have been seriously damaged by *P. solenopsis*. Severe economic damage (estimated of US \$ 40,000-50,000) was reported in Punjab and Haryana in 2007 and more severe attack was anticipated in 2008-2009 [10, 13].

Before conducting this studies it was observed during field visits several host plants found to harbor this pest. Incidence of mealybug was sudden decreased during rainy days and in winter and again it appears with highest peak during summer season. In this view these studies carried out to know the host range and its migration throughout the year in Jalna district. This information will be helpful for researchers, extension workers, farmer community and all the stockholders related to cotton and other field crops for devising sound management strategies.

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2. Material and Methods

The field studies surveys carried out to know the diversity of

host plants of *P. solenopsis* and its migration study during 2014 to 2017 from eight talukas of Jalna district (Fig 1).



Fig 1: Location of fields surveyed for host plants in eight blocks of Jalna district

This survey conducted randomly at specific locations like field, field border, roadside, water channel and local gardens in cotton cultivation area of Jalna district. Host plants further categorized into field crops, vegetables, ornamentals, fruit crops, medicinal and weeds. The observation of host plant recorded as 0-4 grade scale Nagrare *et al.* [17] viz. 0-no incidence, 1-scattered appearance of mealybug on plant, 2-appearance of mealybug on one branch, 3-incidence on more than 2 branch or half portion of plant and 4-severe incidence on whole plant (Table 1.). During field survey photographs of host plant were captured and samples of plant taken to laboratory for the preparation of herbaria. These herbaria and plants sample submitted to Dept of Botany JES College Jalna for identification of plants species. Records of host plant related to seasonality, severity and distribution at various locations was note down. Close monitoring on migration and carryover of the pest from host to alternate plant studied out throughout the year. Recommendation for cultural and other management strategies was given to farmers while survey for future suppression of this pest.

3. Result and Discussion

The result of present studies reveals that total 51 plants observed as host belonging to 15 plant families (Table 1.). Among them highest number of host plants of *P. solenopsis* belonged to plant family like Malvaceae (12) > Solanaceae (8) > Astaraceae (6) > Euphorbiaceae (6) > Amaranthacea (6) > Portulaceae (3) (Fig. 2). This studies are similler with findings of Arif *et al.* [3] who reported cotton mealybug

observed on 154 plant species belongs to 53 plant families in Pakistan which are some field crops, vegetables, ornamentals, fruit & horticultural plant, spices and weeds. Abbas *et al.* [1] reported 55 plant species across 18 plant families from cotton growing district of Punjab and Sindh in Pakistan. Abbas *et al.* [1] reported 55 plant species across 18 plant families from cotton growing district of Punjab and Sindh in Pakistan. *P. solenopsis* is polyphagous insect on at least 203 host plant species belonging to 56 plant families with as preference to families Asteraceae, Solanacea, Malvaceae and Fabaceae Ben-Dov *et al.* [7].

Weeds are major host of *P. solenopsis* and total 23 weed species observed which occupies 57% of host this result are in agreement with earlier results of S. Venilla *et al.* [21] who reported 108 weeds species from 32 plant families as host of *P. solenopsis* in India, of which total 60 % weed plants are host of cotton mealybug. These host plant species recorded in present studies categorized into field crops, vegetables, ornamentals, fruit crops, medicinal and weeds. Out of 51 hosts plants they are field crops (4), Vegetables (7), Ornamentals (8), fruit plant (2), medicinal (1) and weeds (29) (Fig 4). These results are confirms with the studies of Arif *et al.* [3] who reported cotton mealybug observed on 154 plant species belongs to 53 plant families in Pakistan which are some field crops, vegetables, ornamentals, fruit & horticultural plant, spices and weeds.

In present study new plant species *Corchorus olitorius* (Malvaceae) observed to be new host of cotton mealybug *P. solenopsis*.

Table 1: Host plant of *P. solenopsis* observed during survey conducted during 2014-17

| Sr. no | Family | Botanical name | Common Name | Plant Category | Location | Season | Grade |
|--------|----------------|-----------------------------------|------------------------------------|----------------|-------------------|---------------------|-------|
| 1 | Acanthaceae | <i>Peristrophe bicalyculata</i> | Chebura/ Panicked | Weed | Kadegaon | Winter | 2 |
| 2 | Acanthaceae | <i>Ruellia squarrosa</i> | Ruellia | Ornamental | Kharpudi | Cotton Season | 3 |
| 3 | Aizoaceae | <i>Trianthema portulacastrum</i> | Giant Pigweed | Weed | Shevga | Offseason | 2 |
| 4 | Amaranthaceae | <i>Amarantus viridis</i> | Jangli chulai | Weed | Pokalwadgaon | Offseason | 4 |
| 5 | Amaranthaceae | <i>Digera arvensis</i> | False amaranth | Weed | Kharpudi | Offseason | 2 |
| 6 | Amaranthaceae | <i>Amaranthus paniculata</i> | Chawali | Field Crop | Jalna | Cotton Season | 2 |
| 7 | Amaranthaceae | <i>Amaranthus spinosus</i> | Spiny Pigweed | Weed | Jalna | Cotton Season | 2 |
| 8 | Amaranthaceae | <i>Digera muncata</i> | Tandla | Weed | Jalna | Winter | 2 |
| 9 | Amaranthaceae | <i>Achyranthus aspera</i> | Agarha/ Prickly Chaff | Weed | Jalna | Winter | 2 |
| 10 | Apocynaceae | <i>Calotropis procera</i> | Rai | Weed | Jalna | Offseason | 2 |
| 11 | Astaraceae | <i>Xanthium strumarium</i> | Gokharu/ Bourr weed | Weed | Kadegaon | Cotton Season | 2 |
| 12 | Astaraceae | <i>Helianthus debilis</i> | Beach Sunflower | Ornamental | Jalna Jes College | Cotton Season | 1 |
| 13 | Astaraceae | <i>Parthenium hysterophorus</i> | Congress Grass | Weed | Hastpokhari | Offseason | 4 |
| 14 | Astaraceae | <i>Acmella oleracea</i> | Nag Kuda | Ornamental | Jalna | Cotton Season | 1 |
| 15 | Astaraceae | <i>Lagasea mollis</i> | Jharwad | Weed | Jalna | Cotton Season | 3 |
| 16 | Asteraceae | <i>Chrysanthemum</i> | Shevanti | Ornamental | Jalna | Cotton Season | 2 |
| 17 | Euphorbiaceae | <i>Acalypha wilkesiana</i> | Copper Leaf | Ornamental | Jalna | Throughout The Year | 4 |
| 18 | Euphorbiaceae | <i>Euphorbia heterophylla</i> | Wild spurge Spurge, Mothi doodhi | Weed | Jalna | Offseason | 2 |
| 19 | Euphorbiaceae | <i>Euphorbia geniculata</i> | Wild Poinsettia | Weed | Kadwanchi | Offseason | 1 |
| 20 | Euphorbiaceae | <i>Euphorbia hirta</i> | Asthama Weed | Weed | Kharpudi | Throughout The Year | 2 |
| 21 | Euphorbiaceae | <i>Euphorbia prostrata</i> | Prostrate Spurge | Weed | Jalna | Offseason | 3 |
| 22 | Euphorbiaceae | <i>Acalypha indica</i> | Indian Acalypha | Weed | Jalna | Offseason | 2 |
| 23 | Malvaceae | <i>Abutilon indicum</i> | Indian Mellow | Weed | Selgaon | Throughout The Year | 4 |
| 24 | Malvaceae | <i>Malvastrum coromandelianum</i> | Malvastrum/three lobe false mallow | Weed | Shelgaon | Cotton Season | 2 |
| 25 | Malvaceae | <i>Hibiscus sabdariffa</i> | Ambadi | Vegetable | Jalna | Cotton Season | 1 |
| 26 | Malvaceae | <i>Sida acuta</i> | Mallow | Weed | Jalna | Offseason | 4 |
| 27 | Malvaceae | <i>Abelmoschus esculentus</i> | Okra | Vegetable | Indalkarwadi | Cotton Season | 2 |
| 28 | Malvaceae | <i>Gossypium hirsutum</i> | Hybrid Cotton | Field Crop | Badnapur | Cotton Season | 4 |
| 29 | Malvaceae | <i>Gossypium arboreum</i> | Desi Cotton | Field Crop | Ambegaon | Cotton Season | 3 |
| 30 | Malvaceae | <i>Hibiscus rosa sinensis</i> | China Rose, | Ornamental | Jalna | Throughout The Year | 4 |
| 31 | Malvaceae | <i>Hibiscus mutabilis</i> | Dixie Rose mallow | Ornamental | Kvk Jalna | Offseason | 2 |
| 32 | Malvaceae | <i>Corchorus olitorius</i> | Jew's Mallow | Weed | Kadegaon | Cotton Season | 3 |
| 33 | Malvaceae | <i>Hibiscus cannabinus</i> | Sorrel Leaves | Vegetable | Jalna | Offseason | 3 |
| 34 | Malvaceae | <i>Malvastrum americana</i> | False Mallow | Weed | Jalna | Offseason | 2 |
| 35 | Oxalidaceae | <i>Oxalis corniculata</i> | Creeping Wood Sorrel, | Weed | Kharpudi | Cotton Season | 2 |
| 36 | Pedaliaceae | <i>Sesamum indicum</i> | Sesame | Field Crop | Jalna | Cotton Season | 3 |
| 37 | Phyllanthaceae | <i>Phyllanthus niruri</i> | Spurges | Weed | Jalna | Offseason | 3 |
| 38 | Portulacaceae | <i>Portulaca oleracea</i> | Pigweed | Weed | Kharpudi | Cotton Season | 4 |
| 39 | Portulacaceae | <i>Portulaca grandiflora</i> | Pink Colour Home | Ornamental | Kharpudi | Offseason | 2 |
| 40 | Portulacaceae | <i>Portulaca quadrifida</i> | Common purslane | Weed | Jalna | Cotton Season | 2 |
| 41 | Rhamnaceae | <i>Zizyphus rotundifolia</i> | Ber | Fruit Tree | Selgaon | Cotton Season | 2 |
| 42 | Rutaceae | <i>Murrayakoenigi</i> | Kadipatta | Trees | Jalna | Cotton Season | 1 |
| 43 | Solanaceae | <i>Solanum lycopersicum</i> | Tomato | Vegetable | Kharpudi | Offseason | 3 |
| 44 | Solanaceae | <i>Capsicum annum</i> | Chili | Vegetable | Kharpudi | Cotton Season | 2 |
| 45 | Solanaceae | <i>Solanum melengena</i> | Brinjal | Vegetable | Indalkarwadi | Cotton Season | 3 |
| 46 | Solanaceae | <i>Solanum tuberosum</i> | Potato | Vegetable | Chapadgaon | Offseason | 3 |
| 47 | Solanaceae | <i>Datura metal</i> | Dhatura | Weed | Jalna | Offseason | 4 |
| 48 | Solanaceae | <i>Physalis minima</i> | Native Gooseberry | Weed | Nanegaon | Offseason | 3 |
| 49 | Solanaceae | <i>Withania somnifera</i> | Ashwagandha | Medicinal | Jalna | Throughout The Year | 4 |
| 50 | Solanaceae | <i>Solanum nigrum</i> | Wonder Berry | Weed | Jalna | Offseason | 2 |
| 51 | Verbenaceae | <i>Lantana camara</i> | Lantana | Weed | Kharpudi | Offseason | 3 |

Table 2: Spatial distribution of host plant of *P. solenopsis*

| Sr. no | Location | No. of host plants |
|--------|--------------------------|--------------------|
| 1 | Fields | 17 |
| 2 | Field borders | 15 |
| 3 | Roadside & water channel | 12 |
| 4 | Gardens | 07 |
| Total | | 51 |

3.1 Seasonality

Cotton mealybug observed throughout the year on *Hibiscus rosa-sinensis*, *Abutilon indicum*, *Parthenium hysterophorus*, *Withania somnifera*, and *Euphorbia hirta* plant species in cotton cultivation agro-ecosystem of Jalna district. These results are in confirmation with findings of Arif *et al.* [3] where he reported *Hibiscus rosa-sinensis*, *Abutilon indicum*, *Withania somnifera* that harbors this pest round the year. *P. solenopsis* observed on 23 plant species during cotton/ crop season, on 23 plants during offseason and on five plants throughout the year (Fig. 3) During crop season mealybug

observed on *Gossipium hirsutum*, *Gossipium arborium*, *Xanthium strumerium*, *Hibiscus subdarifa*, *Abelmoscus esculentus*, *Sesamum indicum*, *Portulaca oleracea*, *Capsicum annum*, *Solanum melongena*, *Ruelia squarrosa*, *Amaranthus paniculata*, *Acmella oleracea*, *Ziziphus mauratiana*. While it was observed on *Datura metal*, *Trientema portulacastrum*, *Lantana camara*, *Chrysanthemum* during winter and offseason that helps to carryover and sustenance of this pest (Table 1). These results are similar with findings of Venilla *et al.* [21] who reported *P. solenopsis* observed on host plant *Xanthium strumerium*, *Digera muricata* during cotton season; *Datura metal* during offseason and *Parthenium hysterophorus* and *Abutilon indicum* throughout the year. These results are supported by findings of Abbas *et al.* [1] where he reported more number of similar host plants observed that harbors *P. solenopsis* during March and April month and most of the common host species between offseason and cotton growing season.

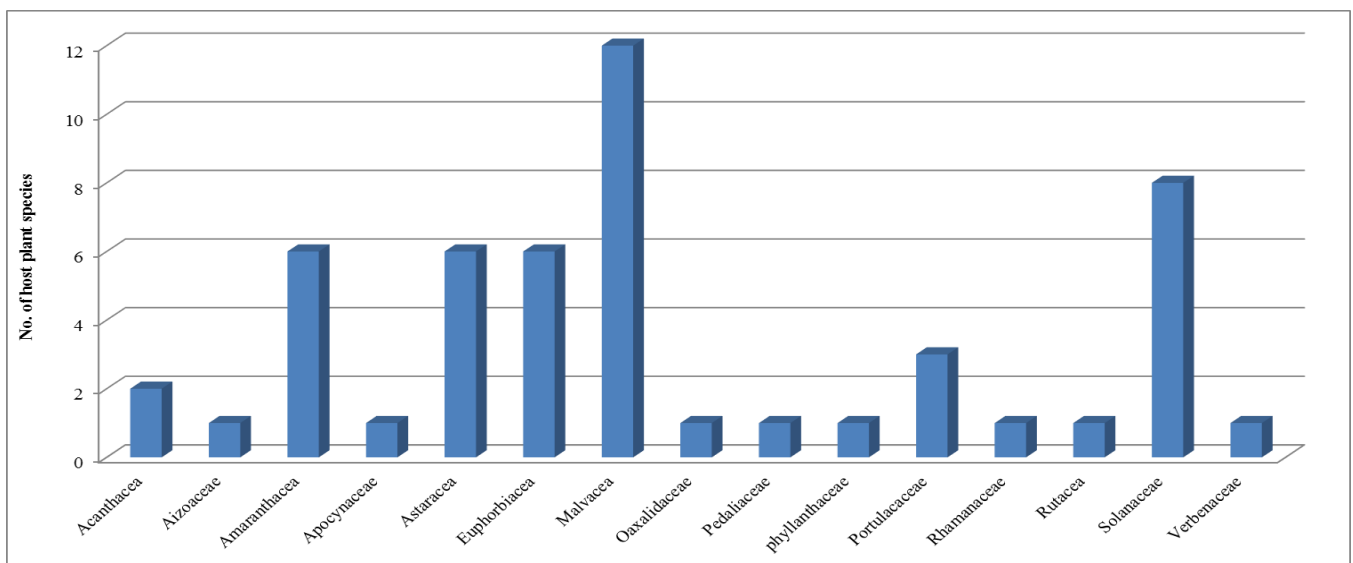


Fig 2: Families of host plants of *P. solenopsis*

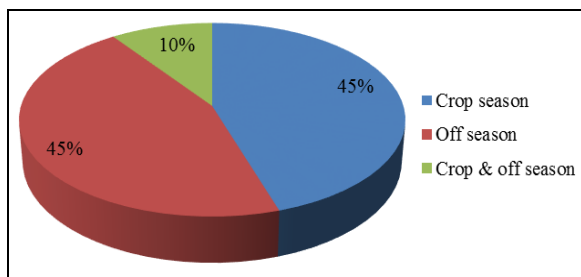


Fig 3: Seasonality of *P. solenopsis* across host plant

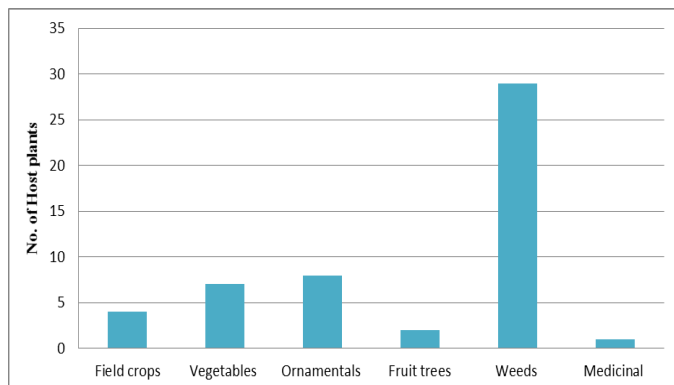


Fig 4: Categoriwise distribution of host plant of *P. solenopsis*

3.2 Severity of infestation

Cotton mealybug observed on different host plant species and its severity recorded by 1st - 4th grade scale. Severity of 4th grade observed on *Gossipium hirsutum*, *Hibiscus rosa sinensis*, *Parthenium hysterophorus*, *Abutilon indicum*, *Akalipha wilkensisiana*, *Xanththium strumarium*, *Sida acuta*, *Datura metal*, *Withania somnifera*, *Hibiscus mutabilis* (Table 1). These results are similar with findings of Venilla *et al.* [21] who reported *Parthenium hysterophorus*, *Sida acuta* had shown G4 severity of *P. solenopsis* across all the cotton zones. It observed moderately from 2nd to 3rd grade on *Trientema portulacastrum*, *Peristroph bicalyculata*, *Lantana camara*, *Digera arvensis*, *Aarathus spinosus*, *Crysenthemum*, *Euphoria hirta*, *Acalipha indica*, *Abelmoscus esculenta*, *Malvastrum Americana*, *Sesamum indicum*, *Physallis minima* etc.

Lower infestation of cotton mealybug observed as 1st grade on *Acmela oeracea*, *Hibiscus subdarifa*, *Calotropis procera*, *Helianthus debilis* and *Euphorbia geneculata* during winter season. Arif *et al.* [3] reported large no. of incidental hosts of *P. solenopsis* that are equivalent to 1st grade incidence in this study and play their role toward carryover of this pest for perpetuation.

3.3 Spatial Distribution of *P. solenopsis*

Out of 51 host plant of *P. solenopsis* in this study, 17 plant species observed within field; 15 plants species on field border, 12 plant species near roadside and water channel while 7 plants species in garden (Table. 2). Cotton mealybug observed roadside on *Datura metal*, *Malvastrum coromandaleum* during offseason and on *Lantana camara*, *Trienthera portulacastrum* during cotton season. It was observed on field border on *Abutilon indicum throughout the year and on Seda acuta*, *Corchorus olitorius* and within field on *Lycopersicum indicum*, *Sesamum indicum*, *Abelmoscus esculentus* and *Euphorbia hirta* during cotton season. It was observed on *Hibiscus rosa-sinensis*, *Acalypha wilkensiana*, *Ruelia* in local gardens. *P. solenopsis* was observed roadside+field borders+within field+water channel on *Parthenium hysterophorus*, *Amaranthus viridis*, *Xanthium strumerium*, *Physallis minima*. Similarity with the results in this study, Venilla *et al.* [21] observed higher numbers of exclusive hosts at central zone were located within cotton fields and in diverse combination of locations (eg. Field borders+roadside, within fields+field borders, field border+roadside and so on).

3.4 Migration and carryover

During field survey of present studies observed that majority of mealybug infestation seen along edges of cotton field from where it spreads inside. Population intensity of cotton mealybug was more on cotton crops during August to October and later declines during November due to decrease in temperature and again from February onward its infestation gradually increases and archived its peak in March to May due to increase in high temperature range. Growth and development of *P. solenopsis* depends upon the availability of food source and climatic conditions Aheer *et al.* [2]. The results of present investigation are confirmed by findings of Shahid *et al.* [19] who reported peak population was recorded during summer season as compared to winter and showed population of mealybug (480 numbers) occurred during the month of August and September. *P. solenopsis* has also ability to overwinter during the winter season Abbas *at al.* 2010 [1]. During winter season environmental temperature declines up to <0 C but insects have ability to withstand climatic changes through behavioral avoidance or physiological diapause Bale & Hayward 2010 [5]. The activity of mealybug was rapid during summer than in winter that may be due to increase in temperature, because multiplication and development increases with increase in temperature. And thus due to extreme hot climatic condition mealybug multiply fast in March and April month.

After harvesting of cotton crop mealybug observe to be survive on summer existing weeds and alternate plants on field border, road side and water channel like *Parthenium hysterophorus*, *Datura metal*, *Abutilon indicum* etc. In absence of cotton crop in the field mealybug population remained on winter crops and on ever green plants, most of them were weeds or perennial ornamental plants such plants serve as carryover and overwintering of the pest Shahid *et al.* [19]. An ornamental shrub china rose found severely infested which also support the carryover of the pest, even during offseason when cotton crop is not available in the fields [3, 17, 1, 21]. These findings supports the present studies of where we observed *Hibiscus rosa sinensis* found severely infested during summer when cotton crop is not available in the fields.

In present studies observed crawlers and adults of mealybug observed to remain inside the cotton stalk stacked on field

borders after harvesting of crop. The results of present study are in confirmatory with findings of Rishi Kumar *et al.* [18] who reported at all locations surveyed the mealy bug (all stages) was found surviving in the stalks throughout the season. The maximum numbers of surviving mealy bugs (adult and crawlers) were found in the deeper side of stacks. Abbas *et al.* [1] reported *P. solenopsis* has a remarkable ability to withstand starvation; mature adult female observed to survive up to 12 days of starvation in October. When a mature adult female was near to death in winter it produced its crawler sac which was sheltered under its moribund body during unfavorable conditions while the development of crawlers was prolonged by the low temperature. After arrival of favorable conditions the crawlers emerged out from beneath the body of dead female in search of favorable feeding sites.

Cotton mealybug spread from their existing sites to field borders and then enters into cotton fields. Black ants facilitates the dispersal and spread of mealybug observed during field survey of this studies. Beside this it also migrated inside field from field borders and corners with the help of water channel during furrow irrigation and sometimes by farm workers by sticking to their clothes. In this way cotton mealybug migrates from cotton field to neighboring alternate host after harvesting of cotton crop and again arrives on same after cotton cultivation. Monga *et al.* [16] reported spread of *P. solenopsis* from border rows to inside of cotton field & need to early detection and its management.

4. Conclusion

In present investigation we observed 51 different plant species recorded as host belonging to 15 plant families from cotton agro-ecosystem of Jalna district. One new plant species *Corchorus olitorius* (Malvaceae) observed to be new host of *P. solenopsis*. Highest Incidence of mealybug observed during August to October on cotton during crop season and observed highest population on summer surviving host plants during March to May in offseason due to increase in high temperature. *P. solenopsis* recorded throughout the year in agro-ecosystem of Jalna district, it migrates from cotton field to neighboring alternate host after harvesting of cotton crop and again comes on same after cotton cultivation. Analysis of host plants seasonality, severity and spatial distribution of cotton mealybug concludes that these alternate host carryover this pest in cotton cultivation area. Integrated management of alternate host plants specially weeds located along roadside, field borders and within fields will help to suppress the pest if practiced regularly.

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