

Diversity, Abundance, and Host Preference of Sap-Sucking Insects on Selected Ornamental and Medicinal Plants in Urban Ecosystems in Khairpur, Sindh, Pakistan

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ABSTRACT

Urban ecosystems in the semi-arid region of Sindh support diverse insect assemblages associated with ornamental and medicinal plants. The present study evaluated species richness, abundance, and host plant preference of sap-sucking insects in Khairpur city, Pakistan. Field surveys were conducted from March to September 2025 across 40 ornamental and 35 medicinal plant species using sweep netting, sticky traps, and direct visual counts. A total of 28 sap-sucking insect species were recorded, belonging mainly to the families Aphididae, Cicadellidae, Coccidae, Aleyrodidae, and Pseudococcidae. Among them, *Aphis gossypii*, *Bemisia tabaci*, and *Phenacoccus solenopsis* were the most dominant and widely distributed species. Host preference analysis revealed that aphids were highly abundant on *Hibiscus rosa-sinensis*, whiteflies showed strong association with *Ocimum tenuiflorum*, while mealybugs (*Phenacoccus solenopsis*) heavily infested *Delonix regia* and *Ziziphus jujuba*. Diversity indicated moderate species richness but strong dominance of a few economically important pest species. Seasonal population peaks were observed during July and August, suggesting a strong influence of climatic conditions on population dynamics. The study highlights the ecological role of sap-sucking insects in urban plant-insect interactions and emphasizes the need for integrated pest management strategies in urban Sindh.

Keywords: Sap-sucking insects; species diversity; host plant preference; abundance; urban ecosystem; integrated pest management

Introduction

The urban ecosystems in semi-arid regions can be viewed as complex landscapes where interactions between plants and insects are influenced by climate, vegetation structure, and human activity. Khairpur, Sindh, and ornamental and medicinal plants are popularly grown in urban gardens, roadway plantations, institution landscapes, and so on. These are plants that are not only beneficial in terms of aesthetics and cultural diversity of urban spaces but also set up microhabitats that support communities of a variety of insects (Safi and Mahmood, 2020; Ali et al., 2014). Of them, sap-sucking insects are especially significant because they are both a part of an ecosystem and a destructive pest (Waseem et al., 2025). Sap-sucking insects are mainly Hemiptera insects such as aphids, whiteflies, mealybugs, and scale insects. They suck plant phloem, decreasing vigor and productivity, as well as passing on viral and bacterial pathogens (Brown and Czosnek, 2002). They tend to cause secondary damage, like honeydew deposition, and sooty mould growth, further undermining plant health. Besides economic consequences, these insects are used to track ecological change, indicating ecological resilience or vulnerability of urban vegetation to semi-arid climatic conditions (Cock et al., 2013).

Across the world, research has highlighted the prevalence of such species such as *Aphis gossypii*, *Bemisia tabaci* and *Phenacoccus solenopsis* in agriculture and urban environments (Malka et al., 2018; Mistral et al., 2021). In Pakistan, their contribution in cotton, vegetable and fruit crops have been investigated mostly (Soomro and Ansari, 2022; Saleem et al., 2016), and there is a gap in comprehending their diversity and preference in urban ornamentals and healthcare plants. The problem of this gap is substantial since urban vegetation may serve as a reservoir of pest populations that can overflow into surrounding agroecosystems, augmenting management difficulties (Mangi et al., 2025). The *Azadirachta indica*, *Ocimum tenuiflorum*, and *Ziziphus jujuba* are medicinal plants with a strong presence in local ethnobotanical culture, whereas *Hibiscus rosa sinensis*, *Bougainvillea spectabilis*, and *Delonix regia* have been incorporated into urban landscapes. Sap-sucking insects often occur in these species, but there has been little systematic reporting of insect diversity, abundance, and host selectivity in urban ecosystems in Khairpur (Tariq et al., 2012). *Phenacoccus Solenopsis* is an invasive cotton mealybug that has emerged as a significant threat in South Asia, not only infesting agricultural, but also non-agricultural plants (Hodgson et al., 2008; Abbas et al., 2010). The fact that it can accommodate a wide range of hosts, such as ornamentals and medicinal ones, highlights the importance of tracking its invasion in urban areas (Arif et al., 2013). Entomopathogenic fungi have proven to be a promising tool in biological control trials (Nawaz and Freed, 2021; Hameed et al., 2012), and ecological reviews have indicated the necessity of integrated pest management strategies (Waqas et al., 2021). It is important to know its place, as well as aphids and whiteflies, to be able to devise management solutions that can be effective against several taxa at once (Abbas et al., 2015; Shad et al., 2012).

Objectives of the Study

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- The present study was designed to achieve the following objectives:
- To document the diversity of sap-sucking insects associated with selected ornamental and medicinal plants in the urban ecosystems of Khairpur, Sindh.
- To quantify their abundance and assess seasonal variations under semi-arid climatic conditions.
- To evaluate host plant preferences, with particular emphasis on dominant species such as *Aphis gossypii*, *Bemisia tabaci*, and *Phenacoccus solenopsis*.

Materials and Methods

Study Area

The study was conducted in Khairpur city, Sindh, Pakistan (27.53° N, 68.76° E), a semi-arid region characterized by high summer temperatures, relatively mild winters, and an average annual rainfall of approximately 120 mm. The urban landscape of Khairpur includes public gardens, roadside plantations, and institutional green spaces where ornamental and medicinal plants are widely cultivated. These habitats provide suitable conditions for the establishment and proliferation of sap-sucking insect populations, making the area appropriate for ecological investigation.

Plant Selection: A total of 40 ornamental and 35 medicinal plant species were selected based on their abundance, cultural importance, and availability within the study area. Common ornamental species included *Hibiscus rosa-sinensis*, *Bougainvillea spectabilis*, *Delonix regia*, *Rosa indica*, and *Cassia fistula*. Frequently observed medicinal plants comprised *Azadirachta indica*, *Ocimum tenuiflorum*, *Ziziphus jujuba*, *Salvadora persica*, and *Citrullus colocynthis*.

Sampling Techniques: Sampling was carried out on a weekly basis during the morning hours (08:00–10:00) using a combination of standard entomological methods to ensure comprehensive data collection.

Sweep Netting: Mobile sap-sucking insects were collected using a standard sweep net by performing systematic sweeps over the vegetation.

Visual Counts: Direct observations were conducted on each selected plant for a duration of 10 minutes, during which all visible insects were recorded to estimate their abundance.

Sticky Traps: Yellow sticky cards were installed near selected plants to capture flying insects, particularly whiteflies and leafhoppers. These traps were replaced at two-week intervals to maintain effectiveness.

Identification of Insects: Collected specimens were preserved in 70% ethanol for subsequent identification. Species identification was carried out using standard morphological keys and authenticated taxonomic literature. The specimens were further verified by comparison with reference collections available at Shah Abdul Latif

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University, Khairpur. Scientific names were confirmed using recognized international taxonomic databases to ensure accuracy and consistency.

Data and Statistical Analysis

Species diversity was evaluated using the Shannon–Wiener index (H') and Simpson's dominance index (D). Insect abundance between ornamental and medicinal plants was analyzed using one-way ANOVA, followed by Tukey's post hoc test where applicable. Host preference was determined through the relative frequency of insect occurrence on each plant species. Seasonal variation in population dynamics was assessed using repeated measures ANOVA based on monthly data. All analyses were performed using SPSS v.25 and R v.4.2.2, with statistical significance set at $p < 0.05$.

Results

Species Richness and Diversity

A total of 28 sap-sucking insect species were recorded across 40 ornamental and 35 medicinal plant species. Among the identified groups, the family Aphididae was the most diverse, comprising 10 species. This was followed by Cicadellidae (7 species), Coccidae (5 species), and both Aleyrodidae and Pseudococcidae with 3 species each. The Shannon–Wiener diversity index (H') ranged from 1.85 to 2.34, indicating a moderate level of species diversity within the study area. In contrast, Simpson's dominance index (D) revealed a clear dominance pattern, with *Aphis gossypii*, *Bemisia tabaci*, and *Phenacoccus solenopsis* emerging as the most abundant and influential species.

Table 1. Diversity and abundance of sap-sucking insects on ornamental plants

Plant species	Dominant insect species	Abundance (mean $\pm$ SE)	Diversity (H')
<i>Hibiscus rosa-sinensis</i>	<i>Aphis gossypii</i>	145 $\pm$ 12	2.12
<i>Bougainvillea spectabilis</i>	<i>Bemisia tabaci</i>	98 $\pm$ 9	1.95
<i>Delonix regia</i>	<i>Phenacoccus solenopsis</i>	84 $\pm$ 7	1.91
<i>Rosa indica</i>	<i>Aphis craccivora</i>	54 $\pm$ 6	1.92
<i>Cassia fistula</i>	<i>Cicadellaviridis</i>	41 $\pm$ 5	1.85

Interpretation:

Aphids and mealybugs showed the highest infestation on ornamental plants. *Hibiscus rosa-sinensis* harbored the greatest aphid density, while *Bougainvillea spectabilis* was most preferred by whiteflies. The strong association between *Phenacoccus solenopsis* and *Delonix regia* underscores its status as a key urban pest in Sindh.

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Figure 1. Diversity and abundance of sap-sucking insects on ornamental plants

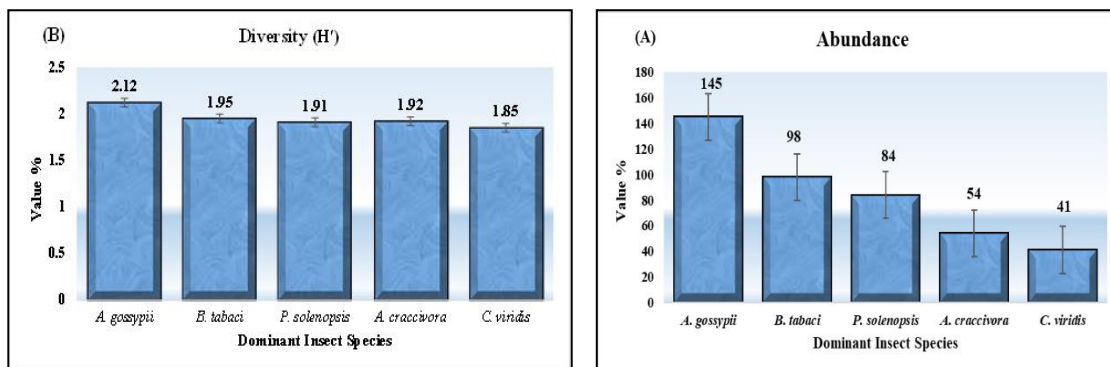


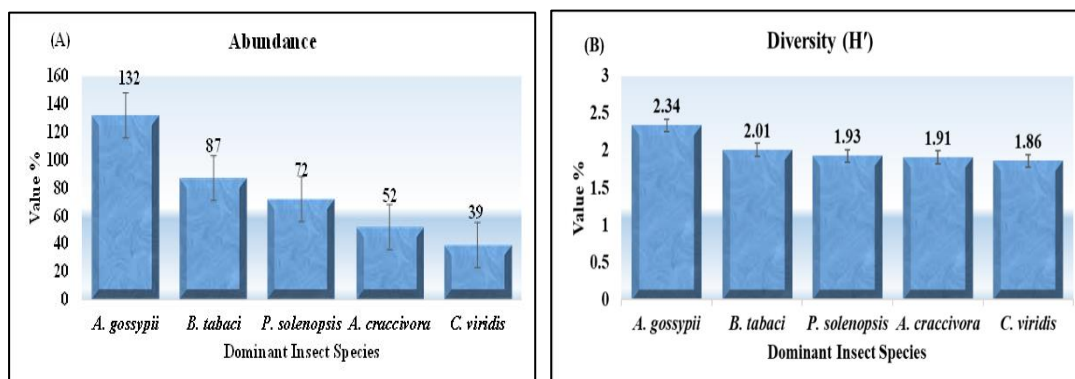
Table 2. Diversity and abundance of sap-sucking insects on medicinal plants

Plant species	Dominant insect species	Abundance (mean $\pm$ SE)	Diversity (H')
<i>Ocimum tenuiflorum</i>	<i>Bemisia tabaci</i>	132 $\pm$ 11	2.34
<i>Azadirachta indica</i>	<i>Aphis gossypii</i>	87 $\pm$ 7	2.01
<i>Ziziphus jujuba</i>	<i>Phenacoccus solenopsis</i>	72 $\pm$ 6	1.93
<i>Salvadora persica</i>	<i>Aphis craccivora</i>	52 $\pm$ 5	1.91
<i>Citrullus colocynthis</i>	<i>Cicadellaviridis</i>	39 $\pm$ 4	1.86

Interpretation:

Medicinal plants exhibited slightly higher diversity than ornamentals. Whiteflies showed a clear preference for *Ocimum tenuiflorum*, while aphids persisted at moderate levels on *Azadirachta indica* despite its insecticidal properties. The high abundance of *Phenacoccus solenopsis* on *Ziziphus jujuba* reflects its adaptability to ethnobotanical hosts.

Figure 2. Diversity and abundance of sap-sucking insects on medicinal plants



Seasonal Abundance

Population peaks occurred during July–August, coinciding with high temperatures and humidity. Aphids were more abundant on ornamental plants, while whiteflies and mealybugs predominated on medicinal plants.

Interpretation:

Seasonal variation strongly influences insect populations. The consistent presence of *Phenacoccus solenopsis* across seasons indicates its strong dispersal ability and persistent threat to both ornamental and medicinal plants.

Discussion

This study provides the first systematic assessment of sap-sucking insect diversity, abundance, and host preference in ornamental and medicinal plants of urban Khairpur. The results revealed moderate species richness with strong dominance by a few taxa, particularly *Aphis gossypii*, *Bemisia tabaci*, and *Phenacoccus solenopsis*. These findings are consistent with global reports showing that urban vegetation often supports simplified insect communities dominated by highly adaptable pest species, leading to ecological imbalance. The control of aphids on ornamental plants, especially on *Hibiscus rosa sinensis* is an indication of how aphids have been known to favor soft foliage that is rich in nutrients. Aphids have been observed to use plants of high nitrogen levels, and ornamental species often have supplemental irrigation and fertilization, both of which provide good colonization conditions. The same tendencies were observed in Hyderabad and Sukkur, where *Aphis gossypii* was found as the most frequently occurring aphid species on the urban ornamentals (Saeed et al., 2016). This indicates that city horticultural activities contribute unintentionally to the increase of the aphid population, and it is required that management of the aphids be employed.

Whiteflies (*Bemisia tabaci*) were found to be highly attracted to medicinal plants, including *Ocussiatenuiflorum*. This host association is noteworthy since *B. tabaci* can be a serious transmitter of plant viruses, such as begomoviruses that can severely affect the quality and productivity of medicinal plants (Oliveira et al., 2001). The peaks in seasonal activity that were recorded during July–August are like past reports in Sindh, where whitefly populations boomed in the presence of high temperature and humidity (Naveed et al., 2019). These results indicate that medicinal plants are susceptible to the spread of viruses in urban areas, and the findings can have future consequences for ethnobotanical activities and human health. Its invasiveness is evidenced using *P. solenopsis* as one of the most common pests in both ornamental (*Delonix regia*) and medicinal (*Ziziphus jujuba*) plants. *P. solenopsis* was originally documented as a cotton pest but has quickly spread its list of hosts to vegetables, ornamentals, and medicinal species throughout South Asia (Hodgson et al., 2008). It is an effective threat among urban ecosystems due to its flexibility to different hosts and its ability to survive in semi-arid environments. Of special interest is the infestation of *Ziziphus jujuba*, which is a culturally important medicinal plant, indicating the capability of the mealybug to compromise ethnobotanical resources. Similar findings of host expansions have been reported in India and Pakistan (Arif et al., 2009), which supports the necessity of continued monitoring and early treatment.

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Diversity measures used in this research revealed a medium level of richness, but high dominance, which is common in disturbed environments. Urban habitat is usually biased towards generalist and invasive species at the expense of specialist taxa which are fragmented due to habitat loss and anthropogenic stresses (McKinney, 2006). This imbalance in ecology is observed through the observed prevalence of aphids, whiteflies, and mealybugs. Although the notions of diversity indicate resistance to changes, the distorted abundance distribution brings to light pest outbreaks that can create destabilized vegetative cover in urban areas. The fact of seasonality further underlines how climatic factors can influence the development of insect populations. The peaks of July-August are related to the humidity of monsoon weather and high temperatures that promote reproduction among sap-sucking insects. The results correspond to the conditions in the regional entomological literature, which indicate comparable seasonal peaks in cotton and vegetable agricultural systems (Shah et al., 2013). *P. solenopsis* over-season persistence indicates it can be a chronic pest or baseline population even in unfavorable conditions. This resilience makes management more complicated, as traditional seasonal management can be ineffective.

On the management side, the research highlights the need to adopt integrated pest management (IPM), specific to the urban ecosystems. The habitat should be diversified and the use of pesticides kept to a minimum to promote the growth of biological control agents like parasitoids and predators (van Lenteren, 2012). Ornamental and medicinal species that are resistant to these pests might help alleviate pest colonization. The need to create awareness campaigns among the masses is also a necessity because urban dwellers are usually ignorant about the issue, and they usually contribute to the spread of the pests by over-fertilizing and poorly maintaining their ornamental gardens. Indicatively, this paper has identified the ecological value of sap-sucking insects within the urban environment of Khairpur. The preemption of *Aphis gossypii*, *Bemisia tabaci*, and *Phenacoccus Solenopsis* is indicative of global pest trends but also indicates host specifications of semi-arid urban areas. The results offer basic information on biodiversity conservation and pest management, and it is important to consider proactive measures in the protection of ornamental and medicinal plants. Future studies are encouraged to consider a broader scope, like molecular identification, seasonal dynamics monitoring, and change in effectiveness of biological control in urban Sindh.

Conclusion

This study provides a baseline overview of sap-sucking insect diversity, abundance, and host associations in the urban ecosystem of Khairpur. A total of 28 species were recorded, with *Aphis gossypii*, *Bemisia tabaci*, and *Phenacoccus solenopsis* as the dominant pests on ornamental and medicinal plants. Diversity was moderate but dominance was high, indicating ecological imbalance typical of semi-arid urban habitats. Pest abundance peaked during July–August, showing a clear influence of seasonal climatic conditions. Key host plants included *Hibiscus rosa-sinensis*, *Ocimum tenuiflorum*, *Delonix regia*, and *Ziziphus jujuba*. The widespread occurrence of *Phenacoccus solenopsis* suggests invasive potential and highlights the need for integrated pest management in urban areas. These findings enhance understanding of

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plant–insect interactions in Sindh and support future work on long-term monitoring, molecular identification, and biological control strategies

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