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PREVALENCE OF COCCID MEALYBUGS (HOMOPTERA: COCCOIDEA) AND IMPACT OF IPM PRACTICES ON ITS POPULATION

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Abstract

Coccid mealybugs are serious pests of horticultural plants in tropical and subtropical countries including Bangladesh and difficult to control. To understand their prevalence, pest status and integrated management practices, a 15-month long surveillance and management practice during 2023-24 were conducted in two gardens at Cherag Ali, Tongi, Gazipur, Bangladesh. Among them, IPM practices were conducted only in Mayer Doya Garden (MDG) and the garden at Animal Treatment Centre (ATC) was used as a control site. To determine the prevalence and seasonal dynamics of coccid insects on different host plants up to head height were assessed through visual counting during fortnightly visits. All diversity parameters indicated a higher population density with 3,878 insects under 7 species (BI=0.0018, d=1.7, H=0.85, D=0.59, 1-D=0.41, 1/D=1.7, and EH =0.44) from 42 plant species at MDG, and a total number of 6,964 insects under 5 species (BI=0.0007, d=3.36, H=1.34, D=0.2979, 1-D=0.7, 1/D=3.36, and EH =0.83) in ATC on 13 host plant species. There is low similarity of insect species (CC = 0.4) in the two study areas. In both study sites, the most suitable host plant, *Mangifera indica*, harbored the maximum number of coccids as well as *Ferrisia virgata*, was the most abundant insect round the year that peaked in summer. The data have revealed that among three treatment measures (cultural, mechanical & chemical) at MDG, chemical insecticide (Dimethoate 40%) reduced the maximum insect population i.e., 96.67%. In addition, several natural enemies of coccid and unaffected plants have also been identified. The current research will help in understanding efficient methods for managing coccid pests and incidence of this insect in the field condition.

Key words: Plant, Coocid mealybug, IPM, Prevalence, Insecticide, Dimethoate, Bangladesh

Introduction

Bangladesh is an agrarian country. It relies heavily on its agricultural sector for food security and economic sustenance. A large portion of its population is involved in cultivating horticultural crops, including fruits, vegetables, and ornamental plants that play a vital role in nutrition and income generation (BBS, 2023). In addition, the diversity

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of plants plays an important role in ecological stability and structure as well as overall biodiversity in various ways (Hancock, 2025). Coccid insects (scale insects and mealybugs) are one of the most important members of this diversity. They are destructive, soft-bodied, small, cryptic, highly adaptive, mostly polyphagous, plant sap-sucking invasive, proliferating, generally multivoltine, dimorphic Homopteran insects. They are major herbivore pests mainly in tropical and subtropical countries. They feed on plant parts resulting direct damage through nutrient depletion, leading to stunted growth, leaf yellowing, and fruit deformation, ultimately resulting in substantial yield and economic losses (Ballal, 2016; Chowdhury and Rahman, 2024). They help promote the growth of black sooty molds on the producing honeydew may reduce growth by reducing the photosynthetic capacity of plants (Franco *et al.*, 2009). Honeydew also attracts ants giving them protection from their natural enemies (Bakry and Abdel-Baky, 2024). The coccid pests mostly act as vectors for various pathogenic diseases such as viral, bacterial and fungal diseases of plants (Chowdhury and Rahman, 2025).

The Tongi area in Gazipur is a significant hub for horticultural production, supplying fresh produce to nearby metropolitan areas, including Dhaka. This region is characterized by a high concentration of peri-urban farms and nurseries. Recent anecdotal reports from local farmers indicate a rising incidence of mealybug infestations on key crops such as brinjal, okra, tomato, guava, and various ornamental plants. The warm and humid climatic conditions of Bangladesh provide a conducive environment for the rapid proliferation of these pests throughout the year (Akhter *et al*., 2022; Chowdhury and Rahman, 2024). Despite these reports, a systematic study documenting the precise prevalence, species composition, and infestation severity of coccid mealybugs in Tongi is conspicuously absent.

To control the coccid pest, farmers are mostly dependent on chemical pesticides. It is a commonly used the quickest method. In Bangladesh, the intensification of agriculture, coupled with the extensive and often indiscriminate use of chemical insecticides, has led to the disruption of natural ecosystems, the development of insecticide resistance (Washim *et al*., 2024). Moreover, this approach is not only environmentally detrimental but also often ineffective against mealybugs due to their waxy coating and cryptic hiding habits, which has made them primary pest in many places (Namadara *et al*., 2025). So, many farmers in some countries for example in Benin (West Africa), destroyed infected plants with coccid to control the infestation (Willink and Moore, 1988), which is un-affordable solution, increased risk to humans, biodiversity and environment. But, IPM emphasizes the integration of multiple control tactics of mechanical, cultural practices, biological control, and the judicious use of safer insecticides (Dara, 2019). While the

principles of IPM are well-established globally (Faria *et al*., 2023), their localized efficacy and impact on specific pest populations like mealybugs in the unique agro-ecological setting (Jose, 2017) of Tongi remain largely unassessed.

Therefore, the present study is designed to survey and determine the prevalence and species diversity and density of coccid mealybugs infestation in a major garden at Cherag Ali, Tongi, Gazipur to evaluate the impact of a suite of IPM practices on the population dynamics of the predominant mealybug species. The findings from this investigation will provide a scientific baseline on mealybug status in the region and generate actionable data for promoting effective, economical, and environmentally friendly management strategies, thereby contributing to the sustainability of horticulture in Bangladesh.

Materials and Methods

Study Area: The study was conducted in two gardens situated in Cherag Ali, Tongi (Fig. 1). It is a sub urban area of the industrial city, Tongi under the administrative Ward 46 of the largest city corporation in Bangladesh named Gazipur city corporation (GCC). The study place is 3.4 km far from the north city corporation area of the capital city, Dhaka. The gardens are situated in the city center and beside a very busy highway known as Dhaka-Mymensingh Highway. The experimental or treatment site is named as Mayer Doya Garden (MDG), which is located on 23.903236° N and 90.398746° E, covers an area of 0.001 sq. Km. The control site is known as the Animal Treatment Centre (ATC),

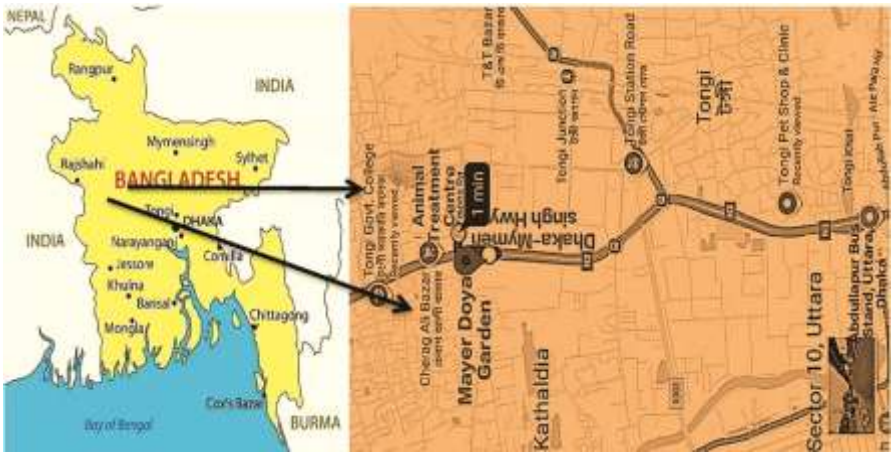


Fig. 1. Map showing Mayer Doya Garden & Animal Treament Centre at Cherag Ali, Tongi, Bangladesh

the city livestock office (23.905163° N and 90.400138° E). It covers an area of 0.0013 sq. Km. Both sites having alluvium, grey, sandy to clayey silt, acidic, iron-rich fertile soil and on an elevation of 11 m from sea level (Simu *et al*., 2016).

Data Collection: A bi-weekly field surveillance of coccid was conducted during the period from March, 2023 to May, 2024. Population extent of adult and nymphs of different coccid insects and its associated organisms extending up to an average height of 2 meters above the ground of the plants were monitored and recorded by absolute method (visual searching and counting) using a 4–10x magnification lens (Chowdhury *et al*., 2022; Chowdhury and Rahman, 2025). Host (Trees: *Areca catechu*, *Artocarpus heterophyllus*, *Azadirachta indica*, *Cocos nucifera*, *Couroupita guianensis*, *Dimocarpus longan*, *Eucalyptus obliqua*, *Ficus microcarpa*, *Malus domestica*, *Mangifera indica*, *Mimusops elengi*, *Moras nigra*, *Tamarindus indica*. Shrubs: *Annona squamosa*, *Artabotrys hexapetalus*, *Bauhinia acuminate*, *Bougainvillea spectabilis*, *Caesalpinia pulcherrima*, *Calliandra haematocephala*, *Camellia japonica*, *Cestrum nocturnum*, *Citrus aurantium*, *Citrus limon*, *Citrus maxima*, *Codiaeum variegatum*, *Euphorbia pulcherrima*, *Hibiscus rosa-sinensis*, *Jasminum sambac*, *Litsea monopetala*, *Piper betle*, *Plumeria obtusa*, *Psidium guajava*, *Rosa involucrata*, *Vernonia amygdalina*, *Vivurnum* sp., *Ziziphus zizyphus*. Herbs: *Abelmuschus esculentus*, *Carica papaya*, *Cyanthillium cinereum*, *Cynodon dactylon*, *Helianthus annuus*, *Mirabilis jalapa*, *Passiflora edulis*, *Portulaca grandiflora*, *Solanum ptychanthum*, *Solanum sisymbriifolium*, *Spathiphyllum wallisii*, *Tagetes erecta*) and non-host plants were identified by a plant taxonomist of National University (NU), Bangladesh and tagged for observations of insects up to head height. The insects were collected from infested plant parts (bark, leaf, twig, fruits, rootstock) and brought to the laboratory of Zoology Department of NU in plastic bags and preserved in 70% alcohol for further examination and identification using standard taxonomic keys (Ullah, 1987; Pellizzari and Germain, 2010; Zhao *et al*., 2014; Morales *et al*., 2016).

IPM trail on treatment site: Chemical practice: The organophosphate insecticide Dimethoate 40% with a brand name Tafgor 40EC was thoroughly sprayed to the infested trees with hand knapsack sprayer at a dose of 2ml/Lit in water. It was applied once a week during the 1st and 2nd weeks of April 2023. Mechanical practice: Sand was applied in the garden during the first week of January 2024 up to a height of about two feet, which covered the tree's base to stop the entry of adult females for oviposit in roots of host plants and nymphs to crawl from underground. Cultural practices: The host plants left without care from March 2024. They were not watered and fertilized. Dusts from the under constructed highway road covered the plant parts (Karar *et al*., 2009). No

treatments were given in the control site. The infestation data were recorded after and before the IPM trials. Finally, the results were compared with the data of study site 2 or the control site.

Data analysis: Data obtained from the sampling sites were subjected to statistical analysis for correlation and test of significance by using one-way ANOVA. Significant differences among means were compared using Duncan multiple range test at 5% level. To describe the amount of species diversity and ecosystem health in a specific area, the Simple Biodiversity Index (BI) (AMNH, 2020), Shannon and Weaver (1949) and Simpson (1949) indices were calculated. To compare the species diversity in different habitat, the index of diversity (d) is used. A higher value of BI and d indicates a greater level of biodiversity in that area (Mclvor, 2025). The Shannon index increases as both the richness and evenness of the community increase. The higher Simpson's index indicated the dominance of one or few species in the community. The Simpson's diversity index (or Gini-Simpson index) = 1-D, the higher value of 1-D indicates greater diversity in the community and Simpson's reciprocal index is 1/D. Shannon's equitability (Evenness Index) (E_H) (Magurran, 2013) is used to measure the evenness of species in a community and a high value of E_H indicates a more even distribution of individuals across different species. Sorenson's Coefficient (CC) was also calculated (Sorensen, 1948) to measure the similarity between two sites ranging from 0 (no similarity) to 1 (complete similarity). The effect of IPM practices was evaluated through counting the population of the coccid on host plant. All Statistical analysis was carried out using R statistical software version 4.4.3.

Results and Discussion

Coccid prevalence in treatment site or MDG: During the study period, since March 2023, 3,878 (BI=0.0018, d=1.7, H=0.85, D=0.59, 1-D=0.41, 1/D=1.7, E_H =0.44) coccid insects of seven species were recorded from 206 afflicted plants out of 473 plants under forty-two host plant species, as well as two *F. virgata* insects discovered from garden's bamboo fence (Tables 1-2, Fig. 2 and Plate 1). The highest mean number of pest insects was found in March 2023, followed by December, February and September ($F=4.047$, $df=629$, $P<0.001$). The pest, *F. virgata* was the highest ($F=4.136$, $df=104$, $P=0.000958$) in number among the insect species found at the study site in different months (Table 2 and Fig. 2).

Table 1. Prevalence of host infestation during the study period in the study areas.

Sl.	Plant Name	A	B	SN	Plant Name	A	B	Sl.	Plant Name	A	B
					MDG						
1	*A. catechu*	2	1	21	*C. limon*	2	1	41	*S. ptychanthum*	6	6
2	*A. heterophyllus*	7	7	22	*C. variegatum*	4	3	42	*T. erecta*	20	4
3	*A. indica*	1	1	23	*E. pulcherrima*	12	2		Total	473	206
4	*C. nucifera*	2	2	24	*H. rosa-sinensis*	7	7		ATC		
5	*C. guianensis*	3	1	25	*J. sambac*	5	2	1	*A. heterophyllus*	2	2
6	*D. longan*	3	1	26	*L. monopetala*	4	4	2	*D. longan*	1	1
7	*E. obliqua*	5	1	27	*P. betle*	5	3	3	*M. indica*	2	2
8	*F. microcarpa*	3	3	28	*P. obtusa*	3	2	4	*T. indica*	4	4
9	*M. domestica*	6	3	29	*P. guajava*	5	5	5	*C. haematocephala*	1	1
10	*M. indica*	13	13	30	*R. involucrate*	3	3	6	*C. maxima*	1	1
11	*M. elengi*	4	4	31	*Vivurnum sp.*	6	6	7	*V. amygdalina*	1	1
12	*M. australis*	5	2	32	*Z. zizyphus*	2	1	8	*P. guajava*	2	2
13	*A. squamosal*	2	1	33	*C. papaya*	1	1	9	*C. variegatum*	3	3
14	*A. hexapetalus*	4	4	34	*C. dactylon*	1	1	10	*Vivurnum sp.*	30	30
15	*B. acuminate*	25	1	35	*C. cinereum*	7	7	11	*A. escu lentus*	5	5
16	*B. spectabilis*	9	8	36	*H. annuus*	8	6	12	*S. sisymbriifolium*	1	1
17	*C. pulcherrima*	4	1	37	*M. jalapa*	10	3	13	*C. papaya*	1	1
18	*C. japonica*	20	18	38	*P. edulis*	10	1		Total	54	54
19	*C. nocturnum*	4	2	39	*P. grandiflora*	200	60	A= Number of host plants			
20	*C. aurantium*	10	2	40	*S. wallisii*	20	2	B= Number of infested plants			

Coccid prevalence in control site or ATC: During the study period from March 2023–May 2024, all plants (54) under 13 species were infested with 6,964 (BI=0.0007, d=3.36, H=1.34, D=0.2979, 1-D=0.7, 1/D=3.36, E_H =0.83) coccid individuals of 5 species (Tables 1-2, Fig. 3 and Plate 1) in the control site. The mean population increased gradually (F=1.405, df=74, P=0.179) on different host plants (F=1.252, df=194, P=0.242) serially during August, September, December-April due to the absence of treatment, and its population was absent or in an insignificant level in other months naturally. February, March 2024 produced the highest incidence (Table 2 and Fig. 3). The most dominant species was identified as *F. virgata* (F=3.036, df=74, P=0.0229).

Plant infestation at treatment site or MDG: 42 species of plants in MDG were infested sometimes of the year. Among them *P. grandiflora* was the highest (F=1.086, df=629, P=0.333) attractive plant to coccid insects. In addition, *M. indica*, *C. japonica*, *P. guajava*, and *F. macrocarpa* plants harbored a substantial (F=1.913, df=629, P=0.00072) number of coccid insects in different months. The maximum infestation was observed during March 2023 (F=4.112, df=629, P<0.00) followed by August and December. The correlation between the number of host plants and infested host plants was 0.94. Maximum coccid insect was identified from the plant leaves (F=0.993, df=20, P=0.39, 63.89%) (Tables 1, 2).

Table 2. Nature of coccid insect infestation in the study areas.

SN	Plant Name	TTL	L	T	SN	Plant Name	TTL	L	T	SN	Plant Name	TTT	L	T
	Icerya aegyptiaca (MDG)				18	*E. pulcherrima*	16	12.5	87.5		*Ceroplastes ceriferus* (MDG)			
1	*A. heterophyllus*	10	100	-	19	*H. rosa-sinensis*	78	11.5	88.5	1	*M. indica*	23	100	-
2	*C. guianensis*	1	-	100	20	*J. sambac*	11	100	-	2	*P. guajava*	1	100	-
3	*F. microcarpa*	46	100	-	21	*L. monopetala*	161	20.5	79.5		*Saissetia oleae* (MDG)			
4	*M. domestica*	Br=3	-	-	22	*P. betle*	71	7	93	1	*D. longan*	3	-	100
5	*M.indica* (Br=28)	204	3	69	23	*P. obtusa*	23	100	-	2	*P. guyajava*	1	-	100
6	*A. squamosa*	Br=1	-	-	24	*P. guajava*	383	6.3	93.7	3	*R. involucrata*	4	-	100
7	*P. obtusa*	2	-	100	25	*Vivurnum* sp.	40	100	-		*I. aegyptiaca* (ATC)			
8	*R. involucrata*	61	6.6	93.4	26	*C. papaya*	185	97	3	1	*A. heterophyllus*	502	100	-
9	*Z. zizyphus*	2	-	100	27	*H. annus*	162	82	18		*Icerya purchasi* (ATC)			
10	*M. jalapa*	1	-	100	28	*M. jalapa*	10	100	-	1	*M. indica*	961	60	40
11	*P. edulis*	6	-	100	29	*P. grandiflora*	166	100	-	2	*C. maxima*	276	100	-
12	*M. nigra*	6	100	-	30	*S. wallisii*	30	100	-		*F. virgata* (ATC)			
	F. virgata (MDG)				31	*T. erecta*	6	-	100	1	*M. indica*	445	95.3	4.7
1	*A. catechu*	4	100	-	32	*S. ptychanthum*	45	-	100	2	*T. indica*	780	4.4	95.6
2	*A. heterophyllus*	99	81.4	18.6		*Phenacoccus solenopsis* (MDG)				3	*C. haematocephala*	281	61.6	38.4
3	*A. indica*	20	-	100	1	*E. obliqua*	2	-	100	4	*D. longan*	2	100	-
4	*C. nucifera*	4	100	-	2	*M. elengi*	8	-	100	5	*C. variegatum*	103	100	-
5	*F. microcarpa*	214	97.2	2.8	3	*M. australis*	11	54.5	45.5	6	*P. guajava* (F=8.6)	1546	62.7	28.7
6	*M. domestica*	15	100	-	4	*B. spectabilis*	24	79.2	20.8		*P. citri* (ATC)			
7	*M. indica*	396	91.4	8.6	5	*C. japonica*	282	89	11	1	*M. indica*	496	100	-
8	*M. nigra*	11	100	-	6	*C. nocturnum*	12	25	75	2	*D. longan*	2	100	-
9	*A. hexapetalus*	182	89	11	7	*H. rosa-sinensis*	35	2.9	97.1	3	*V. amygdalina*	4	100	-
10	*B. acuminata*	19	-	100	8	*Vivburnum sp.*	4	100	-		*P. solenopsis* (ATC)			
11	*B. spectabilis*	56	86	14	9	*C. cinerium*	40	-	100	1	*V. amygdalina*	403	69.4	30.6
12	*C. pulcherrima*	24	16.7	83.3	10	*C. dactylon*	2	100	-	2	*Vivurnum sp.*	51	100	-
13	*C. japonica*	276	94.6	5.4	11	*T. erecta*	7	-	100	3	*A. esculentus* (F=1.4)	873	73.6	25
14	*C. nocturnum*	110	18.2	81.8		*Planococcus citri* (MDG)				4	*S. sisymbriifolium*	181	32.8	67.2
15	*C. aurantium*	14	100	-	1	*A. heterophyllus*	6	100	-	5	*C. papaya*	58	100	-
16	*C. limon*	12	100	-		*Unaspis citri* (MDG)					•SN=Serial No., TTL=Total Insect, L=Insect in			
17	*C. variegatum*	76	100	-	1	*M. indica*	149	100	-		Leaf (%), T=Twig%, Br=Branch%, F=Fruit%			

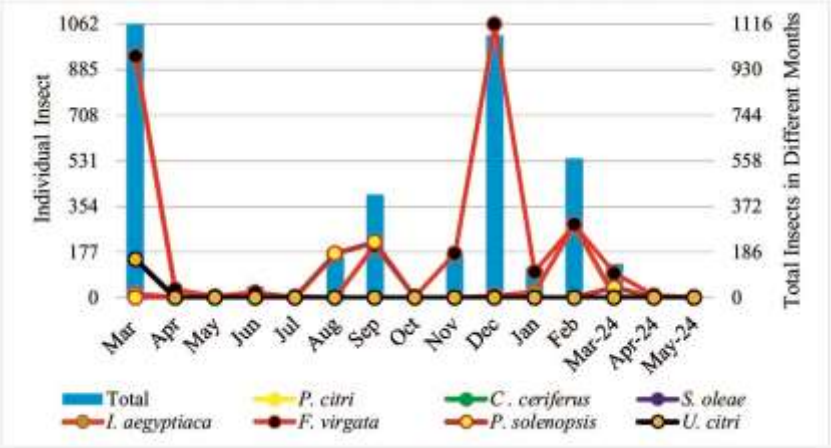


Fig. 2. Effect of IPM on coccid population at MDG.

Plant infestation at the control site or ATC: M. indica was the highest infested plant in different months (F=2.148, df=194, P=0.016), while *P. guajava*, *A. esculentus*, and *T. indica*, respectively, carried a sizable number of insects. The number of infested plants did not significantly vary (F=0.806, df=194, P=0.662) in different months. Plant leaves carried the highest number of insects (F=6.31, df=14, P=0.0134, 76.92%). The most abundant insect pests, *F. virgata*, and *P. solenopsis* were highly attracted by *P. guajava* (F=1.807, df=71, P=0.12, 48.97%) and *A. esculentus* (F=1.46, df=74, P=0.224, 55.75%), respectively (Tables 1, 2).

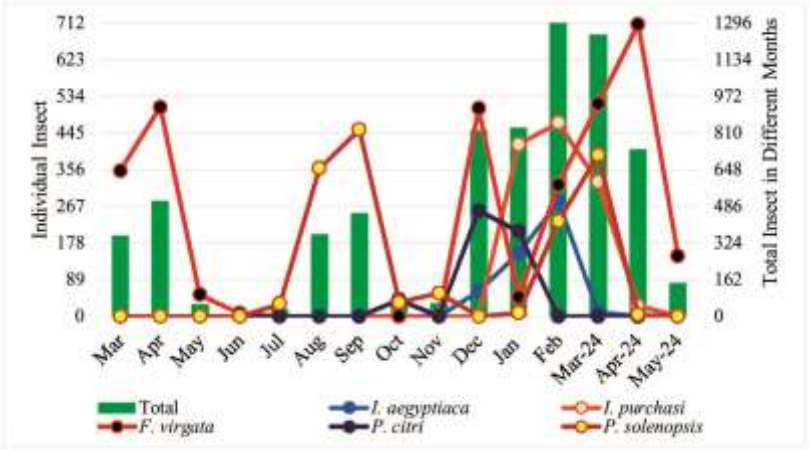


Fig. 3. Incidence of coccid population at ATC.

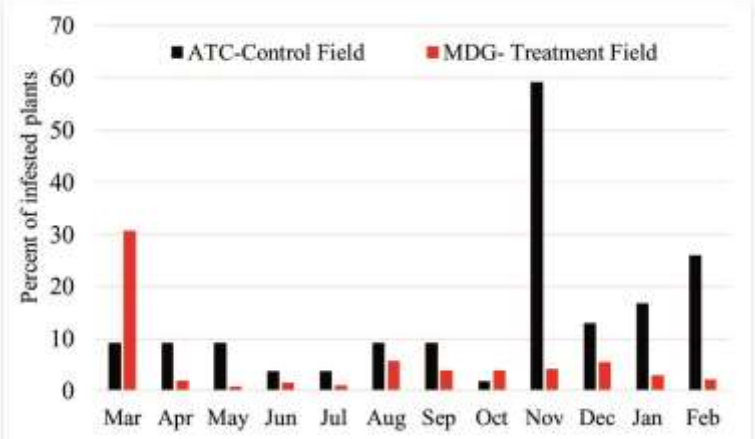


Fig. 4. Effect of IPM on plant infestation from March 2023 to February 2024.

Effects of IPM on plant infestation: The maximum reduction of coccid mealybug's infested plant was observed in chemical application, which reduced infestation significantly from 30.7% to 1.9% (F=6.854, df=51, P=0.0117) just after application (Table 1, Fig. 4). It impacted longer to build up new pest population. Other management practices helped to keep the infestation level lower. So, the pest infestation was always under the threshold level. On the contrary, the pest infestation gradually increased in the control field. In another word, chemical control reduced the maximum coccid mealybugs by 96.67% followed by the mechanical and cultural methods by 88.66% (F=9.102, df=31, P=0.00516) and 76% (F=1.864, df=17, P=0.191), respectively, and showed no significant difference with each other (F=0.594, df=113 P=0.554) (Fig. 2, 3).

Unaffected plant species: A significant number of plants in the treatment site were unaffected, though almost all plants were infested in the control site. However, three plants from three groups in both sites were unaffected, they are *Swietenia macrophylla* from trees, *Tabernaemontana divaricate* from shrubs and *Musa acuminate* from herbs. The complete list has been given below:

In Mayer Doya Garden (MDG): Trees: *Acer caesium*, *Baccaurea motleyana*, *Cycas pectinata*, *Litchi chinensis*, *Madhuca indica*, *Manilkara zapota*, *Phoenix dactylifera*, *Phyllanthus emblica*, *Podocarpus neriifolius*, *Polyalthia longifolia*, *Spondias mombin*, *Swietenia macrophylla*, *Syzygium cumini*, *Wrightia coccinea*. Shrubs: *Aegle marmelos*, *Allamanda cathartica*, *Averrhoa carambola*, *Capsicum frutescens*, *Carissa carandas*, *Citrus sinensis*, *Cycas revolute*, *Dracaena sanderiana*, *Epiphyllum oxypetalum*, *Gardenia*

jasminoides, *Ixora coccinea*, *Kalanchoe pinnata*, *Lawsonia inermis*, *Limonia acidissima*, *Murraya koenigii*, *Murraya paniculata*, *Pandanus amaryllifolius*, Pai tree, *Phyllanthus acidus*, *Punica granatum*, *Rhapis excels*, *Streblus asper*, *Tabernaemontana divaricate*, *Tamarix dioica*, *Jasminum auriculatum*, *Vitis vinifera*. Herbs: *Aloe vera*, *Canna indica*, *Catharanthus roseus*, *Clitoria ternatea*, *Coleus blumeri*, *Dahlia pinnata*, *Elettaria cardamomum*, *Epipremnum aureum*, *Hylocereus undatus*, *Kalanchoe pinnata*, *Ocimum tenuiflorum*, *Pilea peperomioides*, *Tradescantia spathacea*, *Musa acuminate*, *Nymphaea odorata*, *Petunia atkinsiana*, *Portulaca grandiflora*, *Oxalis triangularis*.

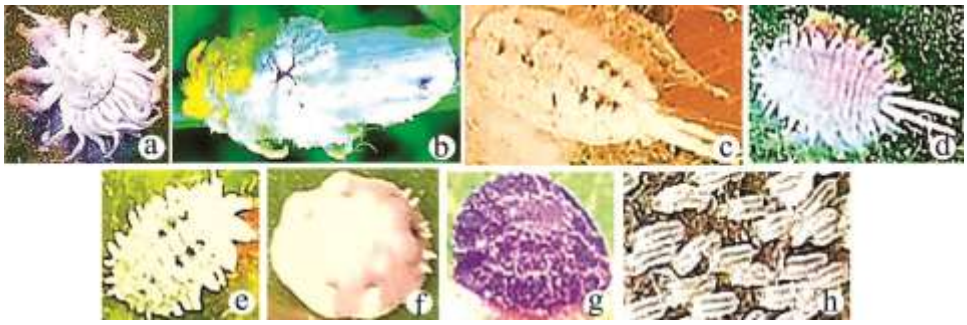


Plate 1. The identified coccids (a. *I. aegyptiaca*, b. *I. purchasi*, c. *F. virgata*, d. *P. citri*, e. *P. solenopsis*, f. *C. ceriferus*, g. *S. oleae* and h. *U. citri*, respectively) from the study sites.

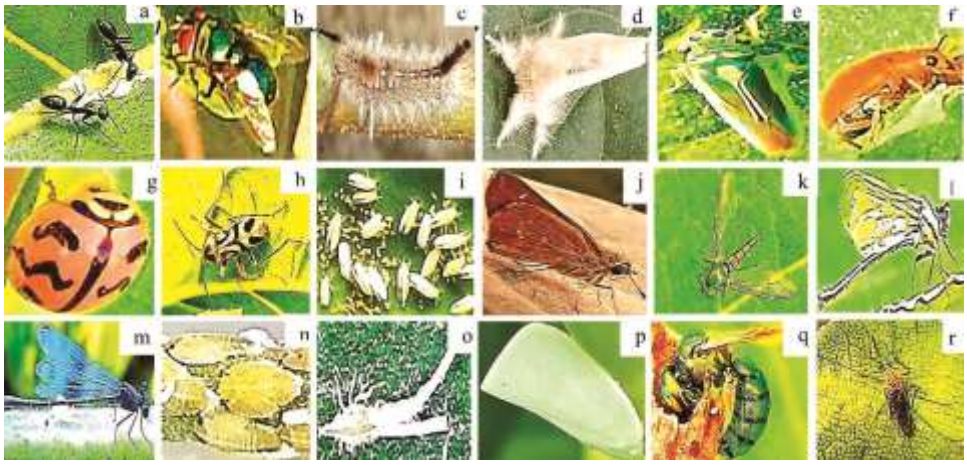


Plate 2. Different identified insects other than coccids in the study sites: a Ants (*C. japonicas*); b Fly (*C. rufifacies*); c-d Moth (*Dasychira sp.*, Lymantriinae); e Grasshopper (*Kolla sp.*); f-h Beetles (*A. femoralis*, *C. sexmaculata*, *C. annularis*); i Whiteflies (*B. tabaci*); j Butterfly (Pelopidas); k Dolichopodidae (*Condylostylus sp.*); l-m Coenagrionidae (*Pseudagrion sp.*, *Argia sp.*); n-o Psyllid (*D. citri*, larva); p Flatidae; q wasp (*Abeja sp.*); r Mosquitoes (*Mosquito sp.*).

In Animal Treatment Centre (ATC): Trees: *Acacia auriculiformis*, *Borassus flabellifer*, *Delonix regia*, *Moringa oleifera*, *Swietenia macrophylla*. Shrub: *Tabernaemontana divaricate*, Herb: *Musa acuminate*.

Biological agents other than coccid mealybugs in the study sites:

List of organisms found in Animal Treatment Centre (ATC): Six different ant species, viz., *Camponotus japonicas*, *Camponotus pennsylvanicus*, *Monomorium floricola*, *Solenopsis invicta*, *Tapinoma melanocephalum*, and *Wasmannia auropunctata* were found to have a mutual relationship with the coccid colony. In addition to protecting the colony from predators, they were found to consume the coccid's body wax and honeydew. In addition, several insects, such as the moth (*Dasychira* sp., Lymantriinae), and house flies (*Chrysomya rufifacies*, *Musca domestica*) maintained mutual relations to feed on honeydew. A variety of predators including birds (*Acridotheres tristis*, *Alcedp atthis*, *Copsychus saularis*, *Corvus macrorhynchos*, *Corvus splendens*, *Dicrurus macrocercus*, *Gracupica contra*, *Orthotomus ruficeps*, *Passer domesticus*, *Pycnonotus cafer*, *Streptopelia chinensis*), beetles (*Aulacophora femoralis*, *Chlorophorus annularis*, *Cheilomenes sexmaculata*), whiteflies (*Bemisia tabaci*), butterflies (*Pelopidas* sp.), spiders (*Hersilla* sp.) and lizard (*Hemidactylus* sp.) were found in close proximity to the coccids colony (Plate 2).

Coccids' indirect enemies including dragonflies (*Argia* sp., *Pseudagrion* sp., *Chrysosoma* sp., *Coeliccia* sp., *Condylostylus* sp.) were found in ATC, they might lower the number of other pray insects on coccids. A competitive relationship was observed with insects like leafhopper (*Kolla* sp.), Psyllid (*Diaphorina citri*), Flatidae due to their similar sap-feeding nature; Parasitic relationship with Chrysididae wasp (*Abeja* sp.) was also observed. No relationship was found with distinct group insects like Mosquitoes (Plate 2). The number of different biological agents with mealybugs was fewer in ATC which was one of the causes of mealybug abundance.

In MDG: Although different species of insects were found with mealybugs in MDG just like ATC before the treatment, after treatment only very few insects such as a very small number of *D. citri*, *A. femoralis* and ant was found. Especially after chemical treatment, along with mealybugs other insects were also greatly reduced.

Infestation of Coccids: In MDG, only one plant species was seen to be fed on by *P. citri* and *U. citri*, two of the seven polyphagous coccid species (Morales *et al*., 2016), however, at least two to thirty-two plant species were attacked by the other five coccid species (Table 2). In ATC, one plant species was seen to be fed on by *I. aegyptiaca*, one

of the five polyphagous coccid species (Morales *et al*. 2016), however, at least two to seven plant species were attacked by the other four coccid species. Previous studies have shown that many coccid pests can be grown or survive on alternative hosts that they have not previously colonized, and a greater proportion of commercially significant coccid bug species are linked to a wide variety of host plants. For instance, among the identified species, *P. citri* infested the highest number of host plants of at least 344 genera across 112 families, while *U. citri* invaded the fewest, with 24 host genera from 17 families (Morales *et al*., 2016). The current study found *F. virgata* as the most prevalent, infesting the most plant varieties, indicating its increased adaptability, capability for reproduction, and abundance in Bangladesh (Khan, 2020; Chowdhury and Rahman, 2025). The main factors that determine an insect's polyphagous nature are a plant's susceptibility and varied morphological, physiological, and chemical traits including nitrogen, proteins, minerals, and water concentrations. Additionally, the broader area of leaves and number of twigs draw attraction to coccid insects and other sucking insects (Schultz, 1983; Tian *et al*., 2025).

Seasonal effects on coccid population: The majority of coccids are found in tropical and subtropical areas (Hodgson, 2017; Islam *et al*., 2017). Bangladesh, a tropical environment with both dry and rainy seasons with high humidity during specific times defines the current study areas (Khan *et al*., 2024). Coccids react to various weather conditions differently, it could account for the differences in insect population density between plants. The seasonal environment of the coccid species was favorable for the growth of host plants, and coccid species were only found during particular seasons (Plata *et al*., 2023) as it was found that *F. virgata* and *P. solenopsis* peaked in the summer and monsoon, respectively, in the control site. In Aligarh, India, *P. solenopsis* on okra peaked in monsoon (Zia and Haseeb, 2019) consistent with the present study. The largest population of *F. virgata* was observed in April in this study. Its peak activity period in Indian Sandalwood occurred in April in Bangalore, India (Shanbhag and Sundararaj, 2017). The highest number of *Icerya* species (monophlebids) was found in February, which was consistent with those of Akter *et al*. (2017). According to the study's findings, depending on the season, the coccid population on host plants was either nonexistent or extremely low due to death or migration in adverse climates. They take shelter underground, behind bark, or inside the trunk for pupation, shielding themselves from predators, adverse weather conditions, and other unknown dangers (Vercher *et al*., 2023). They show downward migration due to the availability of food and mutualistic interactions with ants are other important factors (Yadav *et al*., 2025). Seasonal, biotic, abiotic, and anthropogenic influences, location, the substrates they consume, plant vigor

and coccid migration all have an impact on the density of coccid population (Gurr, 2004; Kanna, 2024).

Effect of IPM practices: The present findings of different treatment approaches to control coccid pest populations concluded that cultural, mechanical, and chemical methods are promising control approaches as shown earlier in different studies (Karar *et al*., 2009; Dara, 2019). It was seen that to control the total coccid pest population, treatment should be given four times in a year, namely, at the beginning of the months of February, April, August and December. They are naturally regulated in May, June, July, October and November when no separate artificial treatment is needed. Integrated pest management approaches, including judicious use of pesticides, mechanical practices, cultural practices, biological control or conservation of natural enemies of coccid, managing sugar-feeding insects and coccid-protecting insects and application of extracts from not-attacked plants offer promising avenues for minimizing the damage caused by mealybug pests (Karar *et al*., 2009; Rakesh *et al*., 2023).

Moreover, biological control of coccid pests can be achieved by releasing their natural enemies. It is considered the effective long-term solution to the mealybug infestation by keeping the pest population under the threshold level and maintaining the safety of the environment. There are a number of natural enemies that can be used to manage mealybugs including commercially available predatory insects and naturally occurring parasitoid wasps and predators as found in the present study.

The unaffected plants and plant parts like leaves, bark juice, flowers, and seeds might have some sort of chemical deterrent against coccid insect pests (Akter *et al*., 2017). Biological control of mealybugs involves using natural enemies like predatory beetles, parasitic wasps, lacewings, and spiders to manage pest populations (Aman *et al*., 2021). They can be further studied to find natural and environmentally friendly control remedies for pest management.

Conclusion

Coccids are common pests of plant species, feeding on their parts and spreading diseases caused by various viruses, bacteria and fungi (Morales *et al*., 2016). Identifying their dispersal or distribution patterns and understanding their roles, and control in different habitats and ecosystems requires frequent and extensive studies, which are lacking in Bangladesh. MDG and ATC provided an isolated and small ecosystem where the roles of different pest insects and the effects of different IPM methods can be easily understood. To determine coccids' population dynamics and their control, the present study

investigated their seasonal prevalence and the impact of different control methods. In this study, seven and five coccid species were found infesting 42 and 13 plant species in MDG and ATC, respectively. However, the number of insect biota was drastically reduced by chemical application and followed by other control measures. This study suggests that these insects have a wide range of hosts and feeding habits, enabling them to survive longer in a changing ecosystem, which demands continuous monitoring and proper control action.

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