European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: Applied Website:
https://farmclin.com/

Differential response of mealybug (Coccidohystrix insolita) to botanical extracts on resistant and susceptible brinjal (Solanum melongena) varieties

Vaishnavi Gupta, S.P Srivastava*, Sandhya Pandey

Department of Zoology, P.P.N. P.G. College, Kanpur, Uttar Pradesh, India

***Corresponding author:** S.P. Srivastava
Email: vaishnavibunny225@gmail.com

ABSTRACT

Mealybug infestation has emerged as a major constraint in brinjal cultivation, leading to significant yield and quality losses. The present investigation was undertaken to evaluate the response of mealybug populations to botanical extracts on resistant and susceptible brinjal varieties under pot culture conditions. Two brinjal varieties, Kashi Taru (resistant) and Pusa Purple Cluster (susceptible), were evaluated against extracts of snake plant and chakri phool applied at different concentrations. The experiment was conducted in two phases during April 2025, and observations on mealybug population were recorded day-wise up to seven days after spraying. The results revealed significant variation in mealybug population depending on the type of botanical extract, concentration, brinjal variety, and days after treatment. Snake plant extract showed comparatively greater suppressive effects on mealybug population than chakri phool extract on both brinjal varieties. Higher concentrations of botanical extracts were more effective in reducing mealybug population than lower concentrations. No insect mortality was recorded in the untreated control during the observation period. The resistant variety Kashi Taru consistently supported lower mealybug populations than the susceptible variety Pusa Purple Cluster across all treatments. Day-wise analysis indicated a time-dependent response of mealybug populations to botanical applications. The findings of the present study suggest that the integration of botanical extracts with host plant resistance can serve as an effective and environmentally safe approach for managing mealybug infestation in brinjal. The combined use of resistant varieties and plant-based botanical treatments offers a sustainable alternative to chemical insecticides in brinjal production systems.

KEYWORDS: Brinjal (Solanum melongena), mealybug infestation, botanical insecticides, host plant resistance, snake plant extract, sustainable pest management.

How to Cite: Vaishnavi Gupta, S.P Srivastava and Sandhya Pandey, (2026) Differential response of mealybug (Coccidohystrix insolita) to botanical extracts on resistant and susceptible brinjal (Solanum melongena) varieties, European Journal of Clinical Pharmacy, Vol.8, No.1, pp. 112-118

INTRODUCTION

Brinjal (*Solanum melongena*) is one of the most widely cultivated vegetable crops in tropical and subtropical regions, particularly in India, where it forms an integral part of daily diets and vegetable-based farming systems. The crop is valued not only for its adaptability and year-round availability but also for its nutritional contribution, as brinjal fruits are a good source of dietary fibre, vitamins, minerals, and antioxidant compounds. Owing to its high consumer demand and multiple harvests, brinjal plays a significant role in enhancing farm income and overall vegetable productivity (Latif & Rahman, 2020; Kaur et al., 2024). Despite its nutritional and economic importance, brinjal productivity is often adversely affected by insect pest infestation, which results in considerable yield and quality losses. Among the emerging pests, the mealybug (*Coccidohystrix insolita*) has become a matter of concern due to its increasing incidence on brinjal crops. Infestation by mealybugs leads to reduced plant vigour, poor flowering and fruit set, and ultimately lower marketable yield. In severe cases, continuous sap extraction weakens plants to such an extent that fruit development is seriously impaired, directly affecting crop profitability (Moore et al., 2014; Mohan, 2021; Manna et al., 2024). Mealybugs damage brinjal plants primarily by sucking sap from tender plant parts, which disrupts normal physiological processes. The secretion of honeydew promotes the growth of sooty mould on leaves and fruits, reducing photosynthetic efficiency and deteriorating fruit quality. Such infestations not only reduce yield but also lower the market value of produce, making effective management of mealybugs essential for sustaining brinjal production (Sartiami et al., 2022; Mohan, 2021).

Management of mealybug populations has traditionally relied on chemical insecticides. However, excessive and repeated use of synthetic pesticides has resulted in problems such as insecticide resistance, pest resurgence, environmental pollution, and risks to beneficial organisms. These limitations have necessitated the search for alternative pest management strategies that are environmentally safe, economically viable, and compatible with integrated pest management practices (Isman, 2020; Koul et al., 2008). Botanical extracts derived from medicinal plants have emerged as promising alternatives to chemical insecticides due to their biodegradable nature and presence of diverse bioactive compounds. Many botanicals exhibit insecticidal, antifeedant, repellent, and growth-regulating properties that can suppress pest populations without causing adverse ecological effects. Consequently, botanical insecticides are increasingly being explored in entomological research as sustainable tools for crop protection (Regnault-Roger et al., 2012; Isman, 2020). Medicinal plants such as snake plant (*Dracaena trifasciata*) and chakri phool (*Illicium verum*) are known to contain biologically active secondary metabolites, including saponins, phenolics, flavonoids, and essential oils. These compounds are reported to interfere with insect feeding behaviour, metabolism, and survival. However, information on their efficacy against mealybug infestation on brinjal, particularly under varietal conditions, remains limited (Olatunji & Afolayan, 2021; Akinyemi & Adebayo, 2023; Wang et al., 2019).

Host plant resistance also plays a crucial role in determining pest incidence and the extent of crop damage. Resistant brinjal varieties may adversely affect insect establishment and development, whereas susceptible varieties often support higher pest populations, leading to greater yield loss. The interaction between host plant resistance and botanical treatments can influence the overall response of insect pests, yet this interaction has not been adequately studied in the context of mealybug management on brinjal (Singh & Gupta, 2023; Latif & Rahman, 2020). Most earlier investigations have examined the effect of botanical extracts or host plant resistance as separate components of pest management. However, studies addressing their combined influence on mealybug infestation, particularly in relation to varietal differences in brinjal, are limited. Since resistant and susceptible varieties differ in their suitability to insect pests, the response of mealybug populations to botanical treatments may vary considerably. Therefore, an integrated evaluation of botanical efficacy across contrasting host plant backgrounds is necessary to obtain a clearer understanding of pest–host–botanical interactions (Acharya & Rattar, 2021; Azad & Islam, 2023). In view of these considerations, the present study was undertaken to evaluate the response of mealybug (*Coccidohystrix insolita*) to botanical extracts of snake plant (*Dracaena trifasciata*) and chakri phool (*Illicium verum*) on resistant and susceptible brinjal (*Solanum melongena*) varieties. The study aimed to record day-wise changes in mealybug population and to assess the influence of host plant resistance on the effectiveness of botanical treatments under controlled conditions.

MATERIALS AND METHODS

2.1 Experimental Site and Brinjal Varieties

The present investigation was conducted during April 2025 under controlled pot culture conditions at the Department of Zoology, P.P.N. P.G. College, Kanpur, Uttar Pradesh, India. Two brinjal (*Solanum melongena*) varieties differing in their susceptibility to insect infestation were selected for the study. Seedlings of the resistant variety Kashi Taru and the susceptible variety Pusa Purple Cluster were procured from Chandra Shekhar Azad University of Agriculture and Technology Kanpur. Healthy seedlings were transplanted individually into 15-L earthen pots containing a homogenized mixture of loamy soil, farmyard manure and river sand in a 2:1:1 ratio. The pots were maintained in a well-ventilated pot-house, protected from rain and natural predators, and exposed to natural photoperiodic conditions. The mean ambient temperature ranged from 25–32 °C with relative humidity between 60–75%. Plants were irrigated as required and kept free from any other pest or disease infestation until they attained 6–8 fully expanded leaves suitable for experimentation.

2.2 Test Insect

The mealybug *Coccidohystrix insolita* was used as the test insect. Natural infestation was allowed to establish on potted brinjal plants, and uniform mealybug populations were maintained prior to treatment application. Only actively feeding individuals were considered for recording observations.

2.3 Collection of Botanical Material

Leaves of snake plant (*Dracaena trifasciata*) were collected from a local nursery, while chakri phool (*Illicium verum*) was procured from a local market. The collected plant materials were washed thoroughly with tap water followed by distilled water to remove dust and surface impurities. The cleaned leaves were shade-dried for two days and subsequently used for extraction.

2.4 Preparation of Botanical Extracts

The dried plant materials were powdered using a mechanical grinder. Extraction was carried out using the Soxhlet extraction method. The obtained extracts were concentrated and stored in airtight containers until further use. Fresh dilutions of the extracts were prepared prior to application according to the required treatment concentrations.

2.5 Experimental Design and Treatment Schedule

The experiment was laid out in a Completely Randomized Design (CRD) with three concentrations of botanical extracts (5 ml, 10 ml and 15 ml) along with an untreated control. Each treatment was replicated five times, with one uniformly infested plant constituting a replication.

The study was conducted in two phases:

First phase (3–11 April 2025):
The effect of snake plant extract was evaluated on
(i) Kashi Taru and
(ii) Pusa Purple Cluster.
Observations were recorded for seven days, excluding holidays.

Second phase (12–22 April 2025):
The effect of chakri phool (*Illicium verum*) extract was evaluated on
(iii) Pusa Purple Cluster and
(iv) Kashi Taru.
Observations were again recorded for seven days, excluding holidays.

2.6 Application of Treatments

Botanical extracts were applied uniformly on infested brinjal plants using a hand sprayer, ensuring complete coverage of leaves and tender plant parts. Control plants were sprayed with distilled water only. Care was taken to avoid spray drift and cross-contamination between treatments.

2.7 Recording of Observations

Observations on mealybug population were recorded at 1 - 7 days on daily basis after spraying (DAS). Mealybug counts were taken from selected plant parts and expressed as mean population per treatment. For developmental observations, the total number of nymphs (n = 30) was recorded by pooling individuals across replications, and the pooled data were used to assess treatment effects.

2.8 Statistical Analysis

The recorded data were subjected to analysis of variance (ANOVA). Square-root transformation was applied prior to analysis to stabilize variance. Day-wise ANOVA was performed to evaluate treatment effects at each observation interval. Standard error (SE) and critical difference (CD) at the 5% level of significance were calculated, and transformed values are presented in parentheses along with original means.

RESULTS

Table 1: Effect of snake plant (*Dracaena trifasciata*) leaf extract on mealybug (*Coccidohystrix insolita*) population on resistant brinjal variety Kashi Taru

Treatments	1 DAS	2 DAS	3 DAS	4 DAS	5 DAS	6 DAS	7 DAS
5ml	1.4 (1.36)	3.0 (1.86)	7.4 (2.80)	11.6 (3.47)	17.0 (4.18)	7.6 (2.84)	2.8 (1.80)
10ml	3.0 (1.86)	5.2 (2.38)	12.4 (3.58)	17.2 (4.20)	23.8 (4.92)	10.8 (3.35)	4.4 (2.20)
15ml	4.6 (2.25)	7.2 (2.77)	15.2 (3.96)	22.0 (4.74)	26.6 (5.20)	13.0 (3.67)	6.8 (2.69)
Control	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
S.E.	0.07	0.07	0.06	0.06	0.03	0.06	0.08
C.D @ 5%	0.14	0.14	0.13	0.13	0.08	0.12	0.18

Values in parentheses are square-root transformed values. Data were analyzed day-wise using ANOVA.

Table 2: Effect of snake plant (*Dracaena trifasciata*) leaf extract on mealybug (*Coccidohystrix insolita*) population on susceptible brinjal variety Pusa Purple Cluster

Treatments	1 DAS	2 DAS	3 DAS	4 DAS	5 DAS	6 DAS	7 DAS
5ml	1.0 (1.19)	2.4 (1.69)	7.2 (2.77)	10.2 (3.26)	14.2 (3.83)	6.8 (2.69)	1.4 (1.36)
10ml	2.0 (1.56)	4.0 (2.11)	12.4 (3.58)	15.2 (3.96)	17.2 (4.20)	10.0 (3.23)	3.0 (1.86)
15ml	3.0 (1.86)	5.8 (2.50)	14.2 (3.83)	18.2 (4.32)	22.2 (4.76)	11.4 (3.44)	3.6 (2.00)
Control	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
S.E.	0.10	0.06	0.05	0.04	0.06	0.06	0.09
C.D @ 5%	0.20	0.13	0.12	0.09	0.12	0.12	0.19

Values in parentheses are square-root transformed values. Data were analyzed day-wise using ANOVA.

Table 3: Effect of chakri phool (*Illicium verum*) flower extract on mealybug (*Coccidohystrix insolita*) population on resistant brinjal variety Kashi Taru

Treatments	1 DAS	2 DAS	3 DAS	4 DAS	5 DAS	6 DAS	7 DAS
5ml	1.2 (1.29)	1.8 (1.49)	5.2 (2.38)	8.8 (3.04)	13.2 (3.69)	5.0 (2.34)	1.0 (1.19)
10ml	1.6 (1.43)	3.2 (1.91)	10.8 (3.35)	13.8 (3.78)	16.0 (4.06)	9.4 (3.14)	3.2 (1.91)
15ml	1.8 (1.49)	4.6 (2.24)	12.8 (3.64)	16.4 (4.10)	20.2 (4.54)	10.6 (3.32)	2.6 (1.74)
Control	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)

S.E.	0.08	0.10	0.05	0.04	0.04	0.05	0.10
C.D @ 5%	0.18	0.21	0.12	0.11	0.09	0.10	0.22

Values in parentheses are square-root transformed values. Data were analyzed day-wise using ANOVA.

Table 4: Effect of chakri phool (*Illicium verum*) flower extract on mealybug (*Coccidohystrix insolita*) population on susceptible brinjal variety Pusa Purple Cluster

Treatments	1 DAS	2 DAS	3 DAS	4 DAS	5 DAS	6 DAS	7 DAS
5ml	0.4 (0.91)	2.0 (1.56)	6.0 (2.54)	7.6 (2.84)	10.4 (3.30)	5.6 (2.46)	1.0 (1.22)
10ml	1.2 (1.29)	2.2 (1.62)	9.6 (3.17)	8.4 (2.98)	12.0 (3.53)	6.4 (2.62)	1.4 (1.36)
15ml	1.4 (1.36)	3.2 (1.91)	13.0 (3.67)	12.4 (3.58)	13.0 (3.67)	7.6 (2.84)	1.2 (1.29)
Control	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
S.E.	0.08	0.09	0.04	0.06	0.06	0.05	0.06
C.D @ 5%	0.18	0.20	0.09	0.13	0.14	0.10	0.12

Values in parentheses are square-root transformed values. Data were analyzed day-wise using ANOVA.

Figure 1: Day-wise mean insect mortality of *Coccidohystrix insolita* on resistant brinjal variety Kashi Taru treated with snake plant (*Dracaena trifasciata*) leaf extract

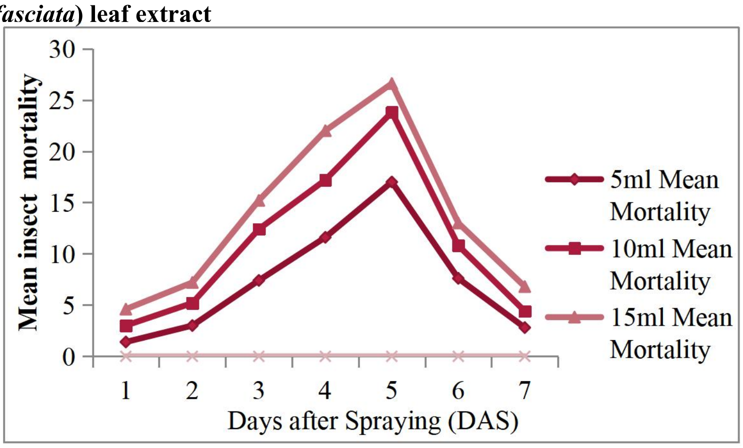


Figure 2: Day-wise mean insect mortality of *Coccidohystrix insolita* on susceptible brinjal variety Pusa Purple Cluster treated with snake plant (*Dracaena trifasciata*) leaf extract

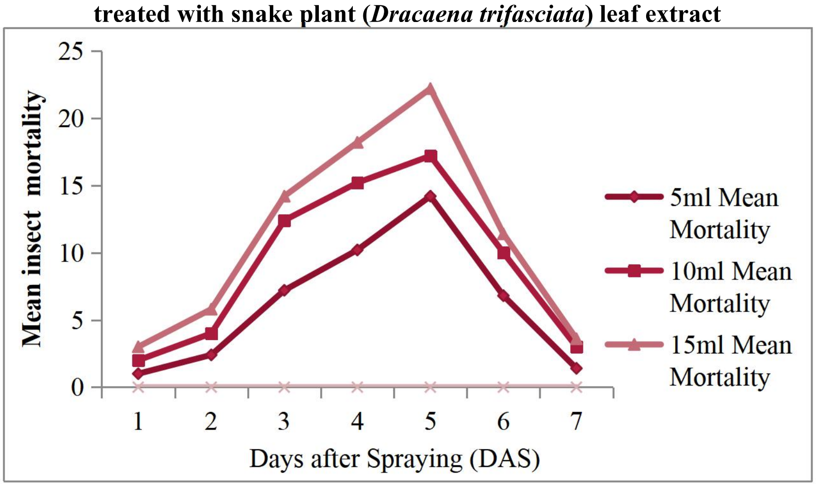


Figure 3: Day-wise mean insect mortality of *Coccidohystrix insolita* on resistant brinjal variety Kashi Taru treated with chakri phool (*Illicium verum*) extract

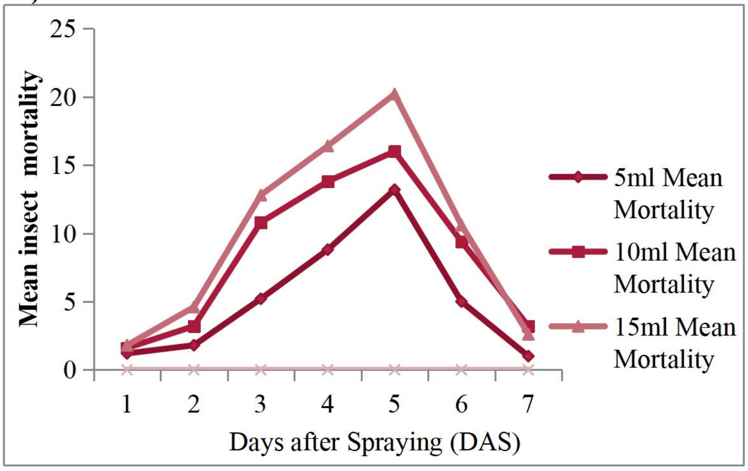
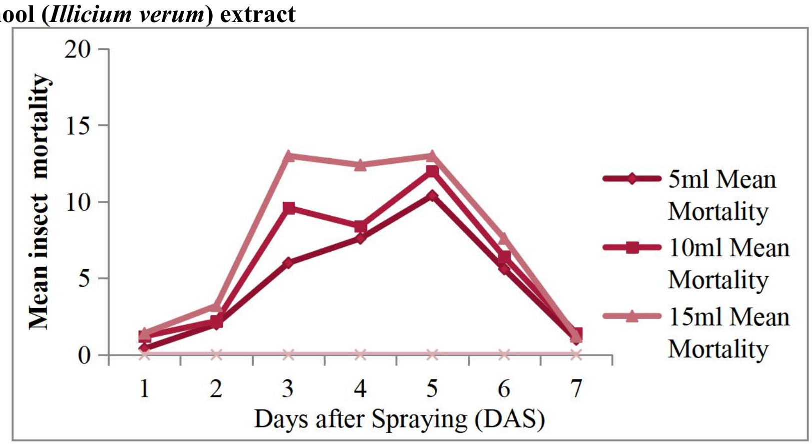


Figure 4: Day-wise mean insect mortality of *Coccidohystrix insolita* on susceptible brinjal variety Pusa Purple Cluster treated with chakri phool (*Illicium verum*) extract



Application of *Dracaena trifasciata* leaf extract significantly influenced the population of *Coccidohystrix insolita* on the resistant brinjal variety Kashi Taru (Table 1). A progressive increase in mealybug population was observed with advancement of days in all treated plants. No insect mortality was recorded in the control during the observation period; however, the magnitude of population build-up varied considerably among concentrations. At 1 DAS, the lowest mean mealybug population was recorded in the 5 ml treatment (1.4), followed by 10 ml treatment (3.0) and 15 ml treatment (4.6). By 3 DAS, mealybug population increased to 7.4, 12.4 and 15.2 at 5 ml, 10 ml and 15 ml concentrations, respectively. The highest mealybug population was recorded at 5 DAS across all treatments, with mean values of 17.0, 23.8 and 26.6 at 5 ml, 10 ml and 15 ml concentrations, respectively whereas no insect mortality was recorded in the control during the observation period. Thereafter, a decline in population was observed at 6 and 7 DAS in all treated plants, with values decreasing to 7.6 and 2.8 at 5 ml, 10.8 and 4.4 at 10 ml, and 13.0 and 6.8 at 15 ml, respectively.

Application of *Dracaena trifasciata* leaf extract significantly affected the population of *Coccidohystrix insolita* on the susceptible brinjal variety Pusa Purple Cluster (Table 2). At 1 DAS, the mean mealybug population was recorded as 1.0, 2.0 and 3.0 at 5 ml, 10 ml and 15 ml concentrations, respectively, no insect mortality was recorded in the control during the observation period. A gradual increase in mealybug population was observed with advancement of days in all treated plants. By 3 DAS, the population increased to 7.2 at 5 ml, 12.4 at 10 ml and 14.2 at 15 ml concentrations. The highest mealybug population was recorded at 5 DAS, with mean values of 14.2, 17.2 and 22.2 at 5 ml, 10 ml and 15 ml concentrations, respectively, whereas no insect mortality was recorded in the control during the observation period. Thereafter, a reduction in mealybug population was observed at 6 and 7 DAS across all treatments. At 6 DAS, the population declined to 6.8, 10.0 and 11.4 at 5 ml, 10 ml and 15 ml concentrations, respectively, and further decreased to 1.4, 3.0 and 3.6 at 7 DAS.

Application of *Illicium verum* extract significantly affected the population of *Coccidohystrix insolita* on the resistant brinjal variety Kashi Taru (Table 3). At 1 DAS, the mean mealybug population was recorded as 1.2, 1.6 and 1.8 at 5 ml, 10 ml and 15 ml concentrations respectively, no insect mortality was recorded in the control during the observation period. With progression of days, a gradual increase in mealybug population was observed in all treated plants. By 3 DAS, the population increased to 5.2 at 5 ml, 10.8 at 10 ml and 12.8 at 15 ml concentrations. The highest mealybug population was observed at 5 DAS, with mean values of 13.2, 16.0 and 20.2 at 5 ml, 10 ml and 15 ml concentrations, respectively. No insect mortality was recorded in the control throughout the observation period. Thereafter, a reduction in population was evident at later stages. At 6 DAS, the population declined to 5.0, 9.4 and 10.6 at 5 ml, 10 ml and 15 ml concentrations, respectively, and further decreased to 1.0, 3.2 and 2.6 at 7 DAS.

Application of *Illicium verum* extract significantly influenced the population of *Coccidohystrix insolita* on the susceptible brinjal variety Pusa Purple Cluster (Table 4). At 1 DAS, the mean mealybug population was recorded as 0.4, 1.2 and 1.4 at 5 ml, 10 ml and 15 ml concentrations, respectively; no insect mortality was recorded in the control during the observation period. A gradual increase in mealybug population was observed with the advancement of days in all treated plants. By 3 DAS, the population increased to 6.0 at 5 ml, 9.6 at 10 ml and 12.4 at 15 ml concentrations. The maximum mealybug population was recorded at 5 DAS, with mean values of 10.4, 12.0 and 13.0 at 5 ml, 10 ml and 15 ml concentrations, respectively. No insect mortality was recorded in the control throughout the observation period. Thereafter, a decline in mealybug population was observed at 6 and 7 DAS across all treatments. At 6 DAS, the population decreased to 5.6, 6.4 and 7.6 at 5 ml, 10 ml and 15 ml concentrations, respectively, and further declined to 1.0, 1.4 and 1.2 at 7 DAS.

DISCUSSION

The present investigation demonstrated that the response of mealybug populations to botanical extracts varied markedly with the type of extract, concentration, brinjal variety, and days after treatment. Across all four experimental combinations, a distinct day-wise variation in mealybug population was evident, indicating that botanical treatments exerted a time-dependent influence on pest population dynamics. Snake plant extract showed comparatively stronger suppression of mealybug population than chakri phool extract on both brinjal varieties. This trend was consistently observed on the resistant as well as the susceptible variety, particularly at higher concentrations. The relatively lower population levels recorded in snake plant–treated plants suggest a greater inhibitory effect on mealybug feeding and survival (Regnault-Roger et al., 2012; Isman, 2020).

Brinjal varietal response played a significant role in determining the effectiveness of botanical treatments. The resistant variety Kashi Taru consistently harboured lower mealybug populations than the susceptible variety Pusa Purple Cluster under both botanical applications. This finding highlights the importance of host plant resistance in limiting pest establishment and multiplication and in enhancing the efficacy of botanical treatments.

The susceptible variety Pusa Purple Cluster supported comparatively higher mealybug populations throughout the observation period. However, even in this variety, botanical applications resulted in noticeable suppression of mealybug population compared to the untreated control. This indicates that botanical extracts remain effective even on susceptible hosts, although the level of suppression is influenced by host plant characteristics.

A common trend observed across all treatments was an initial increase in mealybug population during the early days after spraying, followed by a decline at later observation intervals. This pattern may be attributed to the gradual action of botanical extracts, which often affect insect feeding behaviour and development rather than causing immediate mortality. The untreated controls showed zero insect mortality throughout the observation period, confirming that population changes in treated plants were attributable to botanical applications. The significant differences among treatments, as revealed by day-wise analysis of variance, further support the effectiveness of botanical extracts in influencing mealybug population dynamics (Maqsood et al., 2023; Mollah et al., 2024). Overall, the findings of the present study suggest that integration of botanical extracts with host plant resistance can play a crucial role in the sustainable management of mealybug infestation on brinjal. The combined use of resistant varieties and eco-friendly botanical treatments offers a viable alternative to chemical insecticides and supports environmentally sound pest management strategies.

CONCLUSION

The present investigation demonstrated that botanical extracts exerted a measurable effect on mealybug mortality on brinjal, with variations observed across plant extracts, concentrations, and host plant varieties. Both snake plant and chakri phool extracts were more effective on the resistant variety than on the susceptible one, indicating the role of host plant resistance in enhancing botanical efficacy. No insect mortality was recorded in the untreated control, confirming that observed effects were due to botanical applications. Overall, the study highlights the potential of plant-based extracts as eco-friendly and sustainable alternatives for managing mealybug infestation in brinjal cultivation.

DECLARATIONS

Conflicts of interest: There is no any conflict of interest associated with this study
Consent to participate: There is consent to participate.
Consent for publication: There is consent for the publication of this paper.
Authors' contributions: Author equally contributed the work.

REFERENCES

1. Moore, A., Watson, G. W., & Bamba, J. (2014). First record of the eggplant mealybug Coccidohystrix insolita (Hemiptera: Pseudococcidae). Biodiversity Data Journal, 2, e1042. https://doi.org/10.3897/BDJ.2.e1042
2. Sartiami, D., Adisuseno, W. S., & Rachmatika, N. (2022). Notes on Coccidohystrix insolita on solanaceous crops. Serangga, 27(3), 162–171.
3. Mohan, M. (2021). Evaluation of brinjal cultivars against mealybug Coccidohystrix insolita. Indian Journal of Entomology.
4. Manna, S., Paine, A. K., & Sarkar, M. P. (2024). Headspace volatile changes in brinjal leaves infested by mealybug. Journal of Chemical Ecology.

5. Kaur, R., Singh, H., & Kaur, J. (2024). Diversity of insect pests associated with brinjal ecosystem. International Journal of Tropical Insect Science.
6. Singh, S. P., & Gupta, R. (2023). Host plant resistance in brinjal against sap-sucking insect pests. Journal of Entomological Research.
7. Latif, M. A., & Rahman, M. M. (2020). Influence of varietal resistance on pest incidence in brinjal. Crop Protection, 132, 105106.
8. Isman, M. B. (2020). Botanical insecticides in the twenty-first century: Fulfilling their promise? Annual Review of Entomology, 65, 233–249.
9. Regnault-Roger, C., Vincent, C., & Arnason, J. T. (2012). Essential oils in insect control: Low-risk products. Annual Review of Entomology, 57, 405–424.
10. Koul, O., Walia, S., & Dhaliwal, G. S. (2008). Essential oils as green pesticides: Potential and constraints. Biopesticides International, 4(1), 63–84.
11. Akinyemi, A. O., & Adebayo, T. A. (2023). Phytochemical screening and insecticidal potential of Dracaena trifasciata. Journal of Applied Sciences and Environmental Management, 27(2), 345–352.
12. Olatunji, G. A., & Afolayan, A. J. (2021). Bioactive compounds and pesticidal properties of Dracaena species. South African Journal of Botany, 137, 145–152.
13. Abubakar, M. S., & Musa, A. M. (2020). Insecticidal activity of medicinal plant extracts against sap-sucking insects. International Journal of Tropical Biology.
14. Wang, G., Zhang, L., & Liu, Z. (2019). Insecticidal activity of Illicium verum essential oil against agricultural pests. Industrial Crops and Products, 129, 247–252.
15. Liu, Z. L., & Ho, S. H. (2017). Bioactivity of star anise essential oil against insect pests. Pesticide Biochemistry and Physiology, 135, 52–57.
16. Park, I. K., & Kim, J. (2018). Fumigant toxicity of plant essential oils against insect pests. Journal of Economic Entomology, 111(2), 615–622.
17. Maqsood, S., Ahmad, M., & Hussain, S. (2023). Control of insect pests and yield improvement in brinjal using plant extracts. Pakistan Journal of Botany, 55(4), 1321–1328.
18. Mollah, M. M. I., Rahman, M., & Islam, M. A. (2024). Efficacy of biopesticides against sucking insect pests of brinjal. Journal of Entomology and Applied Biology.
19. Acharya, S. S., & Rattar, I. A. (2021). Evaluation of plant-based extracts against insect pests of brinjal. Indian Journal of Agricultural Entomology.
20. Azad, M. A. K., & Islam, M. S. (2023). Bioefficacy of botanical extracts against major pests of brinjal. International Journal of Zoology Studies, 8(2), 45–51.