

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(10): 1433-1439
www.biochemjournal.com
Received: 27-08-2024
Accepted: 30-09-2024

Harshit Tyagi
Department of Entomology,
School of Agriculture,
ITM University, Gwalior,
Madhya Pradesh, India

Suraj Kumar
Department of Entomology,
School of Agriculture,
ITM University, Gwalior,
Madhya Pradesh, India

Babli Bagari
Department of Entomology,
School of Agriculture,
ITM University, Gwalior,
Madhya Pradesh, India

Corresponding Author:
Harshit Tyagi
Department of Entomology,
School of Agriculture,
ITM University, Gwalior,
Madhya Pradesh, India

Efficacy of plant extracts and Calotropis dust on the feeding deterrence of the blister beetle, *Mylabris pustulata* Thunberg (Coleoptera: Meloidae)

Harshit Tyagi, Suraj Kumar and Babli Bagari

DOI: <https://doi.org/10.33545/26174693.2024.v8.i10Sq.2742>

Abstract

Blister beetles, including *Mylabris pustulata*, represent a serious threat to agricultural productivity by inflicting damage on pulses and grains, which results in decreased crop yields and poses health risks to both humans and animals. This study investigates plant-based alternatives to chemical pesticides, focusing on the efficacy of Calotropis dust, Neem dust, and Neem oil in managing these pests on Hibiscus flowers. The research findings indicate that Neem dust was highly effective in nearly eliminating beetle feeding, suggesting strong potential as a pest control measure. Neem oil also demonstrated significant effectiveness, though its impact was somewhat less pronounced compared to Neem dust. In contrast, Calotropis dust offered only moderate success in controlling beetle damage. These results underscore the promise of botanical treatments as viable, eco-friendly alternatives to chemical pesticides. By adopting such plant-based solutions, agricultural practices can benefit from improved pest management while promoting sustainability and reducing environmental and health impacts associated with synthetic chemicals.

Keywords: Blister beetles, Neem dust, Neem oil, Calotropis dust, Eco-friendly management

1. Introduction

Blister beetles, part of the Meloidae family, are diverse with around 3,000 species globally. They are characterized by their production of cantharidin, a toxin causing skin blistering, which serves as a defense mechanism (Howell and Ford, 1985) ^[4]. These beetles exhibit a wide range of sizes and appearances, from a few millimeters to several centimeters, with striking colors and patterns (Capinera, 2008) ^[1]. Their life cycle includes egg, larval, pupal, and adult stages, with adults feeding on plants and utilizing cantharidin for protection (Eisner and Wiemer, 1999) ^[3].

Blister beetles are widely distributed across India, thriving in diverse environments from the Himalayan foothills to the coastal plains and arid deserts. They are found in temperate regions like the Himalayas, xeric areas such as Rajasthan, and humid subtropical and tropical zones in states like West Bengal and Assam. Their distribution is influenced by climate, vegetation, and the availability of host plants. In these varied ecosystems, blister beetles play significant roles in pollination and can impact agriculture by feeding on crops and reducing yields.

Blister beetles can be damaging to crops like alfalfa, soybeans, and potatoes globally, and in India, they affect staple crops such as lentils and tomatoes, reducing yields and increasing food insecurity (Pappas *et al.*, 2015) ^[7]. Studies have shown that their feeding patterns peak in the morning, and they often aggregate near certain plants (Duraimurugan, 2012) ^[2]. Effective pest management relies on understanding pest density and economic thresholds.

Botanicals offer a natural alternative to synthetic pesticides for managing blister beetles. Plant-based substances like Calotropis dust and neem dust are effective due to their insecticidal properties, causing less environmental harm compared to chemical pesticides (Yadav and Sharma, 2019) ^[9]. Neem oil also helps by disrupting insect growth and development (Kumar *et al.*, 2020) ^[6]. Using botanicals could mitigate the need for synthetic pesticides, which can lead to pest resistance and environmental damage.

This study aims to evaluate the effectiveness of neem dust and Calotropis dust as feeding deterrents for *Mylabris pustulata* in controlled conditions, exploring sustainable pest management options.

2 Materials and Methods

2.1 Evaluation of the relative efficacy of feeding deterrence of plant extracts, Neem dust and Calotropis dust against *M. pustulata* under *in-vitro* conditions

The study was conducted at the Department of Entomology, School of Agriculture, ITM University, Gwalior, located geographically at 26.22 N and 78.18 E, and 211 meters above sea level, in the central plateau and hilly agro-climatic zone of Madhya Pradesh.

2.2 Equipment and Materials Used

The research utilized jars, muslin cloth, rubber bands, Hibiscus flowers, wheat flour, honey solution, cotton, a BOD incubator, pipettes, forceps, and beakers.

2.3 Preparation of Neem and Calotropis Dust

Fresh leaves of Neem (*Azadirachta indica*) and Calotropis (*Calotropis gigantea*) were collected from around the ITM University campus and air-dried in the shade. The dried leaves were ground into powder using a grinding machine. To ensure only fine powder was used, the ground material was sifted through a sieve with a 250 µm pore size.

2.4 Neem Oil Extraction

Neem oil bought from a store is mixed with an emulsifier, like mild dish soap, to blend better with water. Typically, 1/2 to 1 teaspoon of dish soap is added to 1 liter of warm water, followed by 1 teaspoon of neem oil. The mixture should be stirred well, filtered through fine paper or cloth, and stored in a clean, labeled container in a cool, dark place. Joshi and Singh (2021) ^[5] note that emulsifiers enhance the stability and effectiveness of neem oil solutions. Reddy *et al.* (2020) ^[8] emphasize the need for proper formulation in pest control, while Prasad and Sharma (2019) ^[9] cover the specialized equipment required for direct neem oil extraction.

2.5 Insect Collection and Rearing

Adult *Mylabris pustulata* beetles were collected from the crop cafeteria at ITM University's School of Agriculture during the 2023 kharif season to establish a laboratory culture. They were transferred to the Department of Entomology's laboratory in perforated plastic containers covered with muslin and secured with rubber bands. The beetles were maintained on fresh Hibiscus flowers and housed in 500 ml plastic jars, with the flowers replaced daily and jars cleaned regularly. Prior to *in vitro* experiments, selected adult beetles of uniform size were pre-starved in separate plastic jars covered with muslin and secured with rubber bands.

Table 1: List of Botanicals plant extract

Sl. No.	Common name	Botanical name	Plant part used	Concentration (%)
1.	Neem	<i>Azadirachta indica</i>	Seed, leaves	100
2.	Milkweed	<i>Calotropis gigantea</i>	Leaves	50, 70,100

2.6 *In vitro* evaluation of the anti-feedant activity of some botanicals against the Blister beetles:

The study aimed to evaluate the effectiveness of Neem and Calotropis botanicals on blister beetles (*Mylabris pustulata*) under controlled laboratory conditions. To assess the impact on beetle feeding behavior, fresh Hibiscus flowers sourced from untreated areas were treated with various concentrations of these botanicals. Specifically, Calotropis dust was tested at concentrations of 50%, 70% (mixed with wheat flour), and 100%, while Neem dust and Neem oil were applied at 100% concentration. Each treatment was replicated across three separate jars, with each jar containing two beetles and six treated flowers. A control group with untreated flowers was maintained for baseline comparison. Daily observations over a 24-hour period were conducted to monitor the beetles' feeding behavior, including the amount of flower consumption and any signs of reluctance or avoidance. Studies have demonstrated that neem and other botanical extracts can significantly influence insect feeding patterns and pest management (Isman, 2006; Nwangburuka & Ojiambo, 2018) ^[11, 12]. These studies provide evidence that such botanicals can act as effective deterrents by altering feeding behavior.

In addition to monitoring feeding behavior, the research also documented any physical distress or behavioral changes in the beetles, such as increased movement or attempts to escape from treated flowers. This approach is supported by research indicating that botanical treatments can induce significant changes in insect behavior and health (Nwangburuka & Ojiambo, 2018) ^[12]. Observations also included checking the health and appearance of the Hibiscus

flowers for any adverse effects, such as discoloration or wilting, to ensure that the treatments did not harm the plants. This aspect aligns with studies that emphasize the need to evaluate both the efficacy of treatments and their impact on the treated plants (Pandey & Singh, 2011) ^[13].

The study also assessed the residual effects of the botanical treatments to determine if the deterrent properties of Neem and Calotropis persisted beyond the initial application. This involved tracking any delayed reactions or changes in beetle behavior over time. The importance of evaluating residual efficacy is highlighted in research on the longevity and effectiveness of botanical pesticides (Choi & Kwon, 2013) ^[10]. To ensure the reliability and validity of the results, statistical analysis, including analysis of variance (ANOVA), was employed to assess the significance of the observed differences between treatment groups and the control. Statistical methods are crucial in pest control research for validating findings and ensuring that observed effects are not due to random variation (Zar, 2010) ^[14].

The controlled laboratory environment provided consistent conditions necessary for accurate comparisons, enabling a clear evaluation of the botanical treatments' effectiveness. The study's findings contribute to developing eco-friendly pest management strategies and underscore the need for integrated pest management approaches that balance effectiveness with environmental sustainability. By exploring the potential synergistic effects of combining Neem and Calotropis treatments, the research aims to identify more effective pest management solutions and promote environmentally responsible practices (Pandey & Singh, 2011) ^[13].

2.6 Statistical Analysis

The collected data were analyzed using ANOVA (Analysis of Variance) to determine significant differences between treatments at a significance level of $p < 0.05$. The means of the treatments were compared using the critical difference (CD) method. This analysis aimed to provide a comprehensive understanding of the effectiveness of the botanical treatments in managing blister beetle populations.

3 Results and Discussion

3.1 Insect Collection and Rearing

Adult beetles of *Mylabris pustulata* were collected from the crop cafeteria located at School of Agriculture, ITM University during the kharif season of 2023 to establish a laboratory culture. The collected beetles were carefully transported to the Department of Entomology's laboratory at ITM University, Gwalior, in perforated plastic containers that were covered with muslin cloth to ensure adequate ventilation and prevent escape.

Upon arrival at the laboratory, the beetles were acclimatized and maintained on a diet of fresh Hibiscus flowers. They were housed in 500 ml plastic jars, each jar covered with muslin and secured with rubber bands to maintain a controlled environment. The Hibiscus flowers provided as food were replaced daily to ensure freshness and to meet the dietary needs of the beetles. Additionally, the jars were cleaned regularly to avoid any build-up of waste or contamination, thereby maintaining optimal rearing conditions.

For the purpose of the *in vitro* experiments, selected adult beetles were pre-starved to standardize their feeding behavior. These beetles, chosen for their uniform size to ensure consistency in the experiments, were placed in separate plastic jars. Each jar was covered with muslin and secured with rubber bands to prepare the beetles for the experimental conditions, following the methodology outlined by Taggar *et al.* (2015). This pre-starvation process was intended to increase the beetles' motivation to feed during the experiments and ensure that any observed effects could be attributed to the treatments rather than variations in hunger levels.

3.2 *In vitro* evaluation of feeding deterrence

The objective of the study was to evaluate the deterrent effects of different botanical substances on *Mylabris pustulata* under controlled laboratory conditions. The botanicals were applied to fresh Hibiscus flowers, which were collected from untreated areas on the campus, at varying concentrations to assess their effectiveness in deterring beetle feeding.

The experimental design encompassed a comprehensive approach to evaluate the efficacy of different botanical treatments in deterring the feeding behavior of blister beetles. Specifically, Calotropis dust was tested at three distinct concentrations: 50%, 70% (which was mixed with wheat flour to create a 70% concentration), and 100%. In addition, Neem dust was applied at a 100% concentration. Neem oil was also assessed at a 100% concentration.

Each of these treatments was applied to Hibiscus flowers, which served as the food source for the beetles. To ensure the accuracy and reliability of the results, each experimental condition was replicated across three separate jars. This means that for each concentration of Calotropis dust, Neem dust, and Neem oil, three separate jars were used to test the treatment. In each jar, two blister beetles were introduced

along with six Hibiscus flowers that had been treated with the specific botanical dust or oil. This setup allowed for direct observation of how the beetles responded to the treated flowers. To establish a baseline for comparison, a control group was included, consisting of untreated Hibiscus flowers that were not exposed to any botanical treatments. By using this detailed and structured approach, the experiment aimed to accurately determine the deterrent effects of each treatment on beetle feeding behavior. The control group provided a necessary reference point to evaluate the relative effectiveness of the various botanical substances, ensuring that any observed differences in feeding behavior could be attributed to the treatments rather than other factors.

Feeding observations were carried out on a daily for a continuous 24-hour period following the application of the treatments. To ensure that the experimental conditions remained consistent and to provide fresh feeding opportunities for the beetles, new Hibiscus flowers were introduced into each jar every day. This practice was critical to maintaining the quality of the food source and to prevent any potential bias in the results due to flower degradation or wilting.

During each observation period, meticulous records were kept of the number of flowers consumed by the beetles. This included documenting whether the flowers were eaten completely or only partially, with detailed notes on the extent of consumption. The data collection process was systematic, involving careful measurement and recording of each instance of feeding to assess both the frequency and severity of feeding. This comprehensive approach allowed for a thorough analysis of how effectively each treatment deterred beetle feeding and provided insights into the relative efficacy of the different botanical substances in reducing flower consumption. By systematically tracking and analyzing these feeding behaviors, the study aimed to accurately gauge the impact of each treatment on beetle feeding patterns.

This experimental setup allowed for a thorough investigation into how these treatments influenced the feeding patterns and behavior of blister beetles. By comparing how beetles interacted with treated and untreated flowers, the study aimed to provide valuable insights into the potential of these botanical substances as environmentally friendly alternatives for managing blister beetle populations in agricultural settings.

3.3 Evaluation of the botanical's treatments for blister beetle feeding deterrence

The evaluation of treatment effectiveness examined the effects of various botanical substances on the feeding behavior of adult *Mylabris pustulata*, with results documented on a daily basis to observe changes over time. This study yielded important insights into how these treatments influenced beetle activity. The findings are outlined below.

3.3.1 Day 1 Treatment Observations

On the first day of treatment, the efficacy results indicated that all tested botanicals significantly deterred feeding by adult *M. pustulata*. The highest level of feeding deterrence was observed with T₄ (100% Neem dust), followed by T₁ (100% Calotropis dust), T₅ (Neem oil solution), and T₂ (50% Calotropis dust + 50% wheat flour), all of which resulted in a notable reduction in beetle feeding behavior. The least

deterrent effect was recorded with T₃ (70% Calotropis dust + 30% wheat flour).

3.3.2 Day 2 Treatment Observations

On the second day of treatment, the results indicated that all botanical treatments effectively deterred feeding by adult *M. pustulata*. The highest feeding deterrence was observed with T₁ (100% Calotropis dust), followed closely by T₄ (100% Neem dust), which also showed a significant reduction in beetle feeding. T₅ (Neem oil solution) demonstrated moderate effectiveness, while T₂ (50% Calotropis dust + 50% wheat flour) continued to exhibit a deterrent effect. The least effective treatment is T₃ (70% Calotropis dust + 30% wheat flour).

3.3.3 Day 3 Treatment Observations

On the third day, the efficacy of the botanical treatments remained strong against adult *M. pustulata*. T₁ (100% Calotropis dust) recorded the highest level of feeding deterrence followed by T₄ (100% Neem dust) showing substantial effectiveness, while T₅ (Neem oil solution) exhibited a moderate reduction in feeding. T₂ (50% Calotropis dust + 50% wheat flour) maintained its deterrent effect, and T₃ (70% Calotropis dust + 30% wheat flour) continued to show the lowest effectiveness.

3.3.4 Day 4 Treatment Observations

By the fourth day of treatment, the results continued to emphasize the effectiveness of the botanicals. I applied different quantity of Calotropis dust to see the changes in the feeding process of beetles on flowers. T₁ (100% Calotropis dust) sustained its position as the top deterrent followed by T₅ (Neem oil solution) and T₂ (50% Calotropis dust + 50% wheat flour) also contributed to reducing beetle feeding. T₄ (100% Neem dust) demonstrated moderate effectiveness, while T₃ (70% Calotropis dust + 30% wheat flour) remained the least effective treatment.

3.3.5 Day 5 Treatment Observations

On the fifth day, the efficacy trend continued, because of previous day changes in the Calotropis dust treatment we can clearly see the effectiveness on 5th day also, with T₁ (100% Calotropis dust) again showing the highest level of feeding deterrence followed by T₅ (Neem oil solution) which also proved to be quite effective, while T₄ (100% Neem dust) exhibited a moderate reduction in feeding. T₂ (50% Calotropis dust + 50% wheat flour) maintained its deterrent effect, and T₃ (70% Calotropis dust + 30% wheat flour) continued to be the least effective treatment.

3.3.6 Day 6 Treatment Observations

On the sixth day, the effectiveness of the botanical treatments persisted. T₅ (Neem oil solution) leads the highest effectiveness in feeding deterrence followed by T₄ (100% Neem dust) showed a slight resurgence in effectiveness, while T₁ (100% Calotropis dust) also contributed to reducing beetle feeding. T₂ (50% Calotropis dust + 50% wheat flour) exhibited a decrease in effectiveness, and T₃ (70% Calotropis dust + 30% wheat flour) was the least effective treatment.

3.3.7 Day 7 Treatment Observations

On the seventh day, T₄ (100% Neem dust) shows the most effective treatment followed by T₅ (Neem oil solution)

continued showing effectiveness, and T₁ (100% Calotropis dust) provided a moderate level of deterrence. T₂ (50% Calotropis dust + 50% wheat flour) exhibited declining effectiveness, while T₃ (70% Calotropis dust + 30% wheat flour) remained the least effective treatment.

3.3.8 Day 8 Treatment Observations

By the eighth day, T₄ (100% Neem dust) still demonstrated the highest level of feeding deterrence among all treatments followed by T₅ (Neem oil solution) showing strong effectiveness, while T₃ (70% Calotropis dust + 30% wheat flour) contributed to reducing beetle feeding. T₁ (100% Calotropis dust) continued to decline in effectiveness, and T₂ (50% Calotropis dust + 50% wheat flour) shows as the least effective treatment.

3.3.9 Day 9 Treatment Observations

On the final day of treatment, T₄ (100% Neem dust) continued to lead in feeding deterrence, confirming its position as the most effective botanical treatment followed by T₅ (Neem oil solution) displayed a strong deterrent effect, while T₁ (100% Calotropis dust) showed moderate effectiveness. T₂ (50% Calotropis dust + 50% wheat flour) consistently demonstrated lower effectiveness, and T₃ (70% Calotropis dust + 30% wheat flour) again became the least effective treatment throughout the study period.

3.4 Untreated flower observations

The untreated flowers (T₆) exhibited a significant difference from the other treatments. The Blister beetles were feeding on T₆ with great intensity, nearly obliterating the flowers and leaving only a few fragments in the jar. This level of damage was clearly noticeable.

3.5 Comparative effectiveness of the botanicals in managing Blister Beetles

This study evaluates the effectiveness of neem dust and neem oil in repelling blister beetles, both of which significantly reduce their feeding activity. The primary active compound in neem, azadirachtin, disrupts the beetles' feeding processes by interfering with digestion and nutrient absorption, making it difficult for them to feed effectively. This makes neem dust a valuable option for sustainable pest management, offering a natural alternative to synthetic chemicals and supporting environmentally friendly agricultural practices.

Neem oil also shows remarkable efficacy in reducing beetle feeding by creating an inhospitable environment that deters the pests. This reduction in feeding not only protects crops but may also affect beetle reproduction and development, potentially leading to long-term population declines. Thus, neem oil serves as a versatile tool in pest management, emphasizing its role as an eco-friendly solution for controlling blister beetles.

In contrast, Calotropis dust was tested at concentrations of 50%, 70%, and 100% to determine its effectiveness. While it showed some moderate impact on beetle feeding, its overall performance was significantly lower than that of neem treatments. The absence of notable improvement with increased concentrations suggests that Calotropis lacks the same potency as neem. This raises concerns about its practical use in pest management.

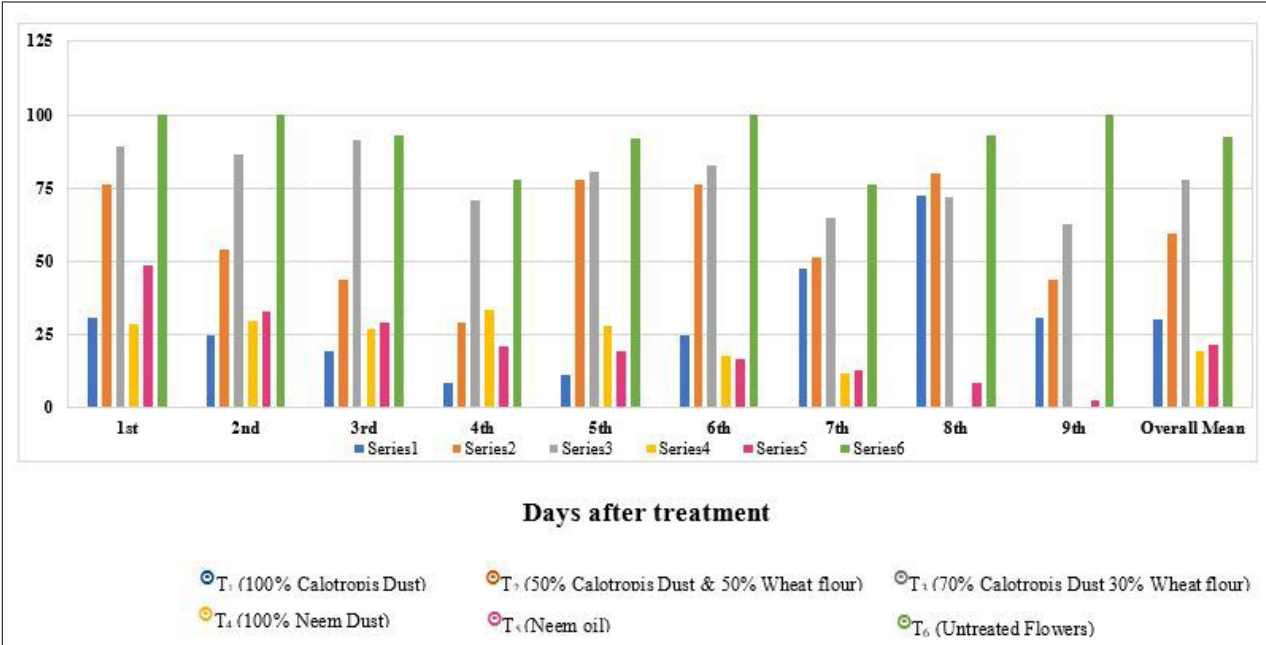
Even at the highest concentration, Calotropis dust did not provide a strong deterrent effect, indicating that it cannot

replace neem-based solutions effectively. Its limited efficacy poses challenges in areas with problematic blister beetle populations. For farmers and agricultural professionals, these findings highlight the necessity of more effective pest control alternatives to ensure crop protection and yield.

Table 2: *In vitro* evaluation of feeding deterrence of Calotropis dust, neem dust and neem oil against *M. pustulata*

Treatments	Treatment details	Days after treatment (DAT)									Overall Mean
		1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	
T ₁	100% Calotropis dust	30.55(33.56) ^a	24.99(30.00) ^a	19.44(26.16) ^a	8.33(16.78) ^a	11.19(19.54) ^a	24.99(30.00) ^b	47.22(43.41) ^b	72.22(58.19) ^c	30.55(33.56) ^c	29.94(32.36)
T ₂	50% Calotropis dust +50%wheat flour	76.39(60.93) ^c	54.16(47.39) ^b	43.88(41.49) ^c	29.16(32.69) ^b	77.77(61.87) ^c	76.39(60.93) ^c	51.39(45.79) ^b	79.72(63.23) ^d	43.67(41.36) ^d	59.17(50.63)
T ₃	70% Calotropis dust + 30% wheat flour	89.02(70.65) ^d	86.57(68.50) ^c	91.22(72.76) ^d	70.91(57.36) ^c	80.55(63.83) ^c	82.57(65.33) ^c	64.90(53.67) ^c	72.05(58.08) ^c	62.50(52.24) ^c	77.81(62.49)
T ₄	100% Neem dust	28.33(32.16) ^a	29.72(33.03) ^a	26.94(31.27) ^b	33.33(35.26) ^b	28.17(32.05) ^b	17.80(24.95) ^a	11.93(20.21) ^a	0.00(0.00) ^a	0.00(0.00) ^a	19.58(23.21)
T ₅	100% Neem oil	48.72(44.27) ^b	32.61(34.82) ^a	28.89(32.51) ^b	21.00(27.27) ^b	19.59(26.27) ^{ab}	16.84(24.23) ^a	12.89(21.04) ^a	8.39(16.84) ^b	2.36(8.84) ^b	21.25(26.23)
T ₆	Untreated flower	100.00(90.00) ^e	100.00(90.00) ^d	93.05(74.71) ^d	77.78(61.87) ^c	91.67(73.22) ^d	100.00(90.00) ^d	76.39(60.93) ^a	93.05(74.71) ^c	100.00(90.00) ^f	92.44(78.38)
C.D.		3.534	5.034	4.063	9.642	15.842	4.523	2.881	4.085	3.496	-
SE(m)		1.134	1.616	1.304	3.095	5.085	1.452	0.925	1.311	1.122	-
SE(d)		1.604	2.285	1.844	4.377	7.191	2.053	1.308	1.854	1.587	-
C.V.		3.555	5.53	4.858	14.098	18.795	5.111	3.921	5.021	5.162	-

The represented data are mean ± standard deviation, and mean in the column followed by the same letter are not significantly different according to DMRT ($p<0.05$).



Mean value in the treatments axis of same letter are not different according to DMRT ($p<0.05$)

Fig 1: Graph showing evaluation of feeding deterrence of Calotropis dust, Neem dust and Neem oil against *M. pustulat*



(A)



(B)

Fig 2: A) prepared feeding material and B) Checking feeding deterrence

4. Conclusion

This study evaluated the deterrent effects of various botanical substances on blister beetles (*Mylabris pustulata*) using controlled laboratory conditions. The research focused on Calotropis dust, Neem dust, and Neem oil applied to Hibiscus flowers at different concentrations: Calotropis dust at 50%, 70%, and 100%, and Neem dust and Neem oil both at 100%. Over a nine-day period, the feeding behavior of the beetles was observed by applying these treatments and recording the number of flowers consumed daily. Neem dust proved to be highly effective, nearly eliminating beetle feeding by the end of the study. Its success is attributed to its natural compounds, which significantly deter beetles from feeding. Neem oil also demonstrated strong repellent properties but was slightly less effective than Neem dust. Despite reducing beetle feeding, it did not achieve the same level of deterrence, possibly due to differences in the mode of action compared to the dust. Conversely, Calotropis dust, regardless of concentration, offered only moderate deterrence. Beetles continued to feed on flowers treated with Calotropis at a higher rate than those treated with Neem-based substances. This indicates that Calotropis dust is less effective than Neem dust and oil.

In summary, Neem-based treatments, especially Neem dust, were found to be more effective in repelling blister beetles compared to Calotropis dust. Neem oil was effective but less so than Neem dust, while Calotropis dust proved to be a less viable option for managing beetle infestations.

The study clearly showed that Neem-based treatments are significantly more effective than Calotropis dust in deterring blister beetles from feeding. Neem dust was identified as the most effective deterrent, reducing beetle feeding rates to nearly zero by the end of the study period. Neem oil also proved to be an effective repellent, though it did not match the level of deterrence achieved by Neem dust, possibly due to differences in application or action.

These results underscore the superior efficacy of Neem-based solutions in pest management, highlighting their potential for use in controlling blister beetle populations. The effectiveness of Neem dust and Neem oil indicates that these treatments could play a crucial role in sustainable

agricultural practices, providing a natural alternative to chemical pesticides.

Conversely, Calotropis dust showed only limited effectiveness as a deterrent. The absence of significant improvement in deterrence at higher concentrations points to its restricted ability to repel beetles effectively. Although Calotropis dust offers some level of repulsion, it falls short compared to Neem-based treatments, suggesting it is a less viable option for managing blister beetle infestations.

Overall, the study suggests that Neem-based treatments are more reliable and potent for repelling blister beetles, supporting their integration into pest management strategies. Calotropis dust, while useful to some extent, is less effective and may not be the best choice for comprehensive pest control.

Future research should include field trials to assess the practical effectiveness of Neem-based treatments in various real-world conditions and pest densities. It is important to focus on refining the formulations of Neem-based treatments and exploring the potential benefits of combining Neem with other botanicals to improve effectiveness and reduce costs. Investigating additional botanical substances with repellent properties could provide more effective or cost-efficient pest control options. An integrated approach that combines botanical treatments with other pest management strategies, such as biological controls or cultural practices, could offer a more comprehensive solution. Expanding research to different geographic regions will help understand the effectiveness of botanical treatments in diverse climates and conditions. Additionally, evaluating the economic feasibility and environmental impact of botanical treatments compared to conventional methods will support the adoption of more sustainable and cost-effective pest management practices.

5. Acknowledgement

Gratitude is extended to the Department of Entomology at the School of Agriculture, ITM University Gwalior, for providing the essential resources and support that made this research possible. Their assistance in facilitating access to equipment and expertise was crucial in achieving the study's

objectives. The department's commitment to advancing research in entomology has significantly contributed to the success of this research.

6. Inherent conflicts of interest

To proceed with the publication of this work, it is confirmed that there are no conflicts of interest.

7. Reference

1. Capinera JL. Encyclopedia of Entomology. 2nd Ed. Springer; c2008.
2. Duraimurugan P. Behaviour of adult *M. pustulata* and indication of aggregation pheromone. Pulses Newsletter Indian Institute of Pulses Research Unit, Kanpur. 2012;23(4).
3. Eisner T, Wiemer DF, editors. Chemical Ecology of Insects 2. Sinauer Associates; c1999.
4. Howell JR, Ford RW. Cantharidin levels in blister beetles (Coleoptera: Meloidae) associated with alfalfa in southern Idaho. Environ Entomol. 1985;14(2):172-174.
5. Joshi MK, Singh RA. Effect of emulsifiers on the stability and efficacy of neem oil formulations. J Agric Food Chem; c2021.
6. Kumar R. Efficacy of neem oil against blister beetles in tomato cultivation. Indian J Agric Res. 2020;54(1):78-85.
7. Pappas ML, Pinto JD, Bologna MA. Blister beetles (Coleoptera: Meloidae) of Greece: taxonomy, biology, and their importance as predators of oil-seed pest insects. Ann Zool Fennici. 2015;52(1-2):61-82.
8. Reddy NSR, Reddy SS, Reddy KS. Neem: A tree for solving global problems. J Biopesticides [Internet]. 2020 [cited 2023 Oct 26]. Available from: <https://www.jbiopesticides.org/article/view/15920>
9. Prasad TV, Sharma MS. Extraction, characterization, and applications of neem oil. Ind Crops Prod [Internet]. 2019 [cited 2023 Oct 26]. Available from: <https://www.sciencedirect.com/science/article/pii/S0926669018307325>
10. Choi WS, Kwon JH. Synergistic effects of combined botanical extracts on pest management. J Agric Food Chem. 2013;61(23):5546-5552.
11. Isman MB. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annu Rev Entomol. 2006;51:45-66.
12. Nwangburuka CC, Ojiambo PS. Impact of neem and other plant extracts on insect feeding behavior and performance. J Insect Sci. 2018;18(1):10-19.
13. Pandey A, Singh R. Efficacy of plant extracts as an alternative to synthetic insecticides: An overview. Pest Manag Sci. 2011;67(2):124-131.
14. Zar JH. Biostatistical Analysis. 5th Ed. Pearson; c2010.