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Dynamics of the weaver ant, *Oecophylla smaragdina,* and its biocontrol potential on the tea mosquito bug, Helopeltis antonii V.Signoret in cashew

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Abstract
The weaver ant, *Oecophylla smaragdina* (Fabricius), constructs a nest using living leaves, and it fiercely predates pests. This research investigates the involvement of the weaver ant, *O. smaragdina*, in managing the tea mosquito bug (*Helopeltis antonii*), a significant pest affecting cashew. The primary aim of this study is to assess the viability of using ants as a biocontrol agent in managing pests in cashew crops. A thorough examination of ant nest dynamics, bug-induced damage patterns was conducted in the cashew orchard where trees naturally hosted ant nests. Trees with ant nests exhibited notably reduced insect damage. The fluctuation in nest numbers was extensively discussed, considering factors such as leaf pavilion (single-leaf nests), green nests (active), and dry nests (abandoned) over time. The beneficial impact of weaver ants in minimizing *Helopeltis* damage vividly illustrates their potential and promising effectiveness in pest management interventions.

Keywords: Weaver ant (*Oecophylla smaragdina*), population dynamics, biocontrol potential, tea mosquito bug, cashew

Introduction
Cashew (*Anacardium occidentale* L.) was introduced to India by Portuguese travelers during the Sixteenth century. It is an important cash crop that belongs to the Anacardiaceae family which is cultivated in numerous tropical regions. These trees have been cultivated for an extended period in Central and South America, Southeast Asia, India, Australia and tropical central Africa Kumar *et al*. [1]. Its cultivation and exploitation are regarded as economically promising for both rural growers and urban industrial processors in terms of employment generated and value added to emerging economies. The production of cashew nuts is being constrained by numerous insect pests, the major pest among them is the Tea mosquito bug *Helopeltis antonii* Signoret which is the dominant species Sundararaju and Bathavatsalam [2]. Chemical pest control in cashew orchards has unleashed a cascade of environmental disasters and potential health threats. The specter of aerial endosulfan haunts the industry. This study emerges as a beacon of hope, illuminating the path toward eco-friendly solutions.
Oecophylla smaragdina Fabricius, commonly known as the Asian weaver ant, is recognized as a highly effective biocontrol agent owing to its diverse predatory behavior towards a wide spectrum of insect pests (Peng *et al* [3]; Peng *et al*. [4]; Peng and Christian [5]; Peng and Christian [6]; Mahapatro [7]; Offenberg and Wiwatwitaya [8]; Olotu *et al*. [9]; Mahapatro and Mathew [10]. In contemporary research, extensive scientific studies have brought to light the remarkable predatory capabilities of *Oecophylla*. Nevertheless, the contribution of red ants to pest control, especially in cashew cultivation, has been largely neglected in the context of India (Mahapatro [7]). Red ants weave a natural defense against the *Helopeltis* pest, protecting cashew trees and fostering a thriving ecosystem. To embrace eco-friendly approach, inorder to cultivate healthy crops and a balanced environment present study was initiated.

Materials and Methods
The study was conducted during 2022-2023 in cashew orchard which was located at Malayadipalayam village, Cuddalore district in cashew variety VRI1. Dynamics of *O. smaragdina* nests were recorded at fortnightly intervals, the ant nests were categorized as simple and composite nests and their numbers were recorded. Simple nests are composed of 1-2 leaves, termed as leaf or ant-pavilions. Composite nests are green (active) nests with a few dried leaves. Nests with all dried leaves are taken as abandoned ant nests (dry nests) and their number was noted as mentioned by Mahapatro and Mathew [10].
To assess the biocontrol potential of *O. smaragdina* against tea mosquito bug, the number of damaged shoots were recorded in trees with ant and without ant nests during Nov 2022 – Apr 2023 from four zones within the tree - low outer canopy, mid outer canopy, top outer canopy and inside the canopy.

Statistical analysis
The data of dynamics on the nest population was carried out in OPSTAT in single factor analysis of Randomized Block Design (F-RBD) and the biocontrol potential of *O. smaragdina* on tea mosquito bug in cashew was analyzed in WASP 2.0 in the two-factor analysis of Randomized Block Design (F-RBD) were transferred to square root transformation $\sqrt{x+0\cdot5}$ and the statistical analysis were done. Critical difference values were calculated at five per cent probability level.

Results and Discussion
Population dynamics of weaver ants
O. smaragdina nests exhibit a division into two distinct categories: simple and composite. Simple nests, typically

serve as shelters for trophobionts, specifically scales, which aggregate at these sites. At regular intervals, both active (green) and abandoned (dry) nests in the composite category were documented and given in Table 1. Across six months from November 2022 to April 2023, a total of 110.3 nests were recorded. April exhibited the highest nesting activity, with peak counts observed in the Leaf pavilion as 18.56, Green nest as 6.24, and in dry nest as 12.32. Conversely, December displayed the lowest nesting activity.

Table 1: Population dynamics of *O. smaragdina* in cashew trees (Nov 2022 – Apr 2023)

Month*	Mean no. of nests/tree#			
	Green nest (G)	Dry nest (D)	Leaf pavilion (L)	Total nests (G+D+L)
November	2.46 (0.38)	4.27 (0.36)	4.62 (0.42)	14.35 (0.11)
December	1.82 (0.22)	5.62 (0.39)	3.56 (0.26)	11.00 (0.39)
January	2.48 (0.36)	1.65 (0.41)	12.42 (0.32)	16.55 (0.19)
February	4.23 (0.31)	1.03 (0.40)	13.64 (0.48)	18.90 (0.10)
March	1.56 (0.18)	5.66 (0.46)	15.48 (0.68)	22.70 (0.34)
April	6.24 (0.62)	12.32 (0.62)	18.56 (0.56)	26.80 (0.33)
S.E(d)	1.24	0.71	0.61	0.66
C.D. (0.05)	2.48	1.42	1.22	1.32

Mean of 10 trees
* Mean of two observations
Values in parenthesis are transformed values $\sqrt{x+0\cdot5}$

Coley and Barone [12] emphasize the ecological importance of ant nests that exhibit continuous movement and adaptability, going beyond the concept of static shelters. In facultative associations, the dynamic nature of these nests becomes a strategic advantage for plants. By providing rewards such as nectar and food bodies, plants attract ants to patrol leaves actively, extending herbivore elimination across broader areas. This dynamic interaction serves to effectively bolster plant defense mechanisms.

In line with Mahapatro and Mathew [10], present findings also revealed a significant contribution of temporary leaf pavilions, constituting an average of approximately 20% of the total nest number (range: 3.8% - 23.8%). This emphasis on leaf pavilions, alongside the observed abundance of green nests, reinforces the dominance of these nest types for *O. smaragdina* across various environments.

Biocontrol potential of weaver ant against tea mosquito bug

Cashew trees with weaver ant (*O. smaragdina*) colonies exhibited significantly lower tea mosquito bug (TMB) infestation or damaged shoots compared to trees without ants, as observed. Notably, the lowest tea mosquito bug infestations were recorded in April (Table 2), coinciding with the cashewnut development stage. Conversely, trees without ant colonies displayed the highest tea mosquito bug damaged shoots in April. These findings suggest that weaver ants provide effective protection against tea mosquito bug infestation during this critical period for cashew production.

Table 2: Biocontrol potential of *O. smaragdina* on tea mosquito bug in cashew (Nov 2022 – Apr 2023)

Month	Mean no. damaged shoots/tree (Tea mosquito bug)#*	
	P	A
November	1.36 (1.16)	2.65 (1.63)
December	1.68 (1.30)	2.73 (1.65)
January	1.70 (1.31)	3.80 (1.95)
February	1.80 (1.34)	2.33 (1.53)
March	1.63 (1.27)	3.18 (1.78)
April	1.25 (1.12)	4.03 (2.01)
S.E(d)	0.01	0.02
C.D.	0.02	0.04
P x A	0.05	

- Mean of four zones * - Mean of five trees P – Presence of nest A- Absence of nest
Values in parenthesis are transformed values $\sqrt{x+0\cdot5}$

Lokkers [13] highlighted the critical role of favorable environmental conditions for *O. smaragdina* populations. This study concluded that a combination of high temperature and high rainfall is essential for their success. Notably, the lower temperature threshold for larval development in *O. smaragdina* was identified as approximately 17°C.

The results of our study align with the findings of Peng *et al.* [14], who proposed that *O. smaragdina* demonstrates superior effectiveness in protecting against insect damage compared to other ant species. This implies that *O. smaragdina* exhibits a higher level of proficiency in preventing harm caused by insects in comparison to its ant counterparts.

Our study adds weight to the growing evidence that *O. smaragdina* acts as a powerful ally in the fight against insect pests. This coincides with Peng *et al.* [3] in their study they reported that the *H. pernicialis* caused serious damage to a tree without *O. smaragdina* nests, a tree with a constant ant population was only slightly damaged, and the damage level never exceeded the control threshold of 6 - 10%. It is suggested that *O. smaragdina* has high potential as a biological control agent.

Strengthening our case for the ecological value of *O. smaragdina* nests, Mahapatro and Mathew [10] demonstrated their remarkable pest control potential. Cashew trees hosting these "harbouring nests" reported significantly lower damage from tea mosquito bugs, below the critical

economic threshold. This resulted in improved yields, suggesting a promising strategy: excluding trees with ant nests from pesticide spraying. Such targeted protection would not only minimize pesticide burden on the environment but also fulfills with our research goals of promoting sustainable pesticide use in cashew cultivation.

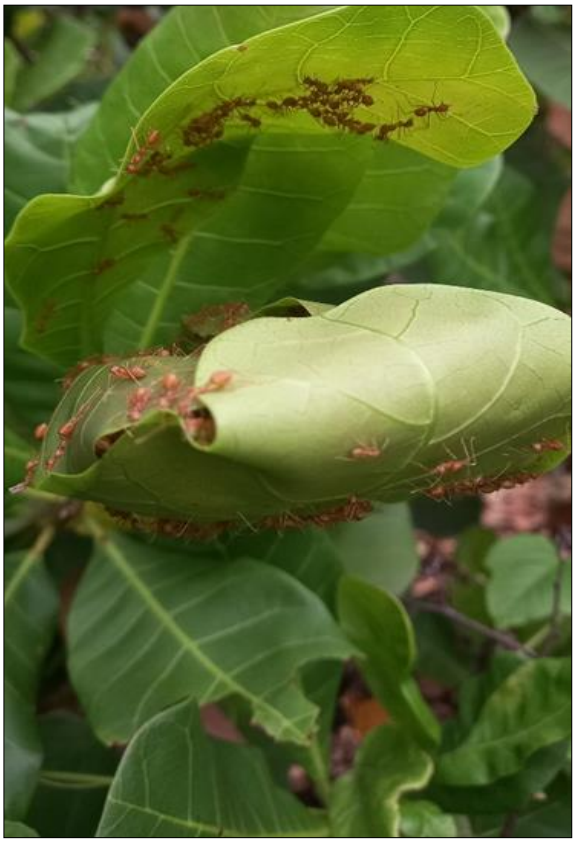

Fig 1a: Leaf pavilion

Fig 1b: Composite nest

Fig 1c: Dried nest

Fig 1: Dynamics of nest on cashew

Fig 2: Tea mosquito bug infestation on cashew

Conclusion

Instead of chemical warfare, manipulating cashew tree communities to favor *O. smaragdina* ants (red ant nests) offers a promising, eco-friendly pest control solution. Studies show trees harboring these fierce ant guardians experience significantly lower damage from harmful tea mosquito bugs (TMB), with rates falling below the critical economic threshold. This translates to higher yields and, crucially, allows us to spare these trees from pesticide spraying, minimizing environmental pollution and promoting input-use efficiency. Imagine thriving orchards brimming with healthy cashews, protected not by chemicals but by nature's own vigilant defenders – a dream achievable through sustainable practices that benefit both farmers and the environment.

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