



Efficacy of natural products against tea mosquito bug (*Helopeltis* spp.) in cashew (*Anacardium occidentale*) based farming system

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ABSTRACT

The cashew tree (*Anacardium occidentale* L.) is a vital crop in tropical regions, yet its production and productivity are hindered due to pest infestation, particularly by the tea mosquito bug (TMB) (*Helopeltis* spp.), causing substantial yield losses. The present study was carried out during 2019–2023 at Kerala Agricultural University, Regional Agricultural Research Station, Pilicode, Kasaragod, Kerala to evaluate the effectiveness of various botanical and natural products in managing TMB infestation in cashew. The variety selected for the study was Madakkathara 1. The experiment was laid out in a randomized block design (RBD), with three replications. Present study was part of the entomological trials of All India Coordinated Research Programme (AICRP) on cashew, wherein, the efficacy of Neem Seed Kernel Extract (NSKE), Kasaragod Dwarf Cows' Urine and several plant leaf extracts were tested against TMB, comparing their results with the standard chemical control (Lambda-cyhalothrin). The results of the study suggested that natural products like neem seed kernel extract can be utilized as an alternative for TMB management in cashew plantations promoting a sustainable and eco-friendly pest management approach without adversely affecting the environment.

Keywords: Botanical insecticides, Cashew, Kasaragod dwarf cows' urine, Neem seed kernel extract, Organic alternatives, Pest management, Tea Mosquito Bug (TMB)

The cashewnut (*Anacardium occidentale* L.) nut kernels contain fat (47%), carbohydrates (22%), protein (21%), moisture (5.9%), iron (5%), phosphorus (0.45%), and calcium (0.05%) along with the vitamins A, D, and E as well as other mineral elements (Jayeola *et al.* 2018). In India, we have a total area of 11.92 lakh ha of cashew which accounts for a production of 7.81 lakh tonnes and a productivity of 766 kg/ha (DCCD 2023). The cashew crop is majorly cultivated in the states of Maharashtra, Goa, Karnataka and Kerala which belongs to the West coast of our country and Tamil Nadu, Puducherry, Andhra Pradesh, Telangana, Odisha, and West Bengal along the east coast and to a limited extent in non-traditional areas of Chhattisgarh, Jharkhand, and Meghalaya (Maruthadurai *et al.* 2012 and Makawana *et al.* 2017). One of the significant constraints in cashew production is pest infestation. Depending upon the extent of damage causing yield reduction, the major pests are tea mosquito bug (TMB) *Helopeltis* spp. Signoret, cashew stem borer (*Plocaederus obesus* Gahn), leaf miner (*Acrocercops syngamma* Meyrick), leaf (*Selenothrips rubrocinctus* Giard) and inflorescence thrips (*Scirtothrips dorsalis* Hood), leaf

and blossom webber [*Lamida (Macalla) moncusalis* Walker], apple and nut borer (*Thylacoptila paurosema* Meyrick) (Maruthadurai *et al.* 2012, Rajkumar, 2020).

TMB attacks the crop during flushing and continues throughout the flowering and nut formation. It single-handedly may cause yield reduction ranging between 20 and 60% (Maruthadurai *et al.* 2012) as one insect is capable of injuring 3 or more shoots/ panicles leading to heavy production decline (Devasahayam and Nair 1986). Four species of TMB, viz. *Helopeltis antonii* Signoret, *H. theivora* Waterhouse, *H. bradyi* Waterhouse and *Pachypeltis measarum* Kirkaldy (Miridae, Hemiptera), are recorded in cashew (Vanitha and Raviprasad 2020).

Both nymphs and adults of TMB form brown-coloured necrotic lesions around the pierced point (Fig. 1). This sucking pest, in turn, causes drying-up of new flushes and inflorescences, as well as shrivelled and damaged nuts, leading to premature nut dropping (Vanitha and Saroj 2015). The entire plant when severely infected, shows typical burnt-up appearance termed as 'shoot/blossom blight' (Fig 2). The gravity of the TMB damage is accelerated by a die-back disease caused by *Colletotrichum gloeosporoides* (Vanitha and Raviprasad 2020). The fungus steadily develops beyond the feeding region, leading to wilting of whole shoots or panicles.

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Fig. 1 TMB damage.

Due to the acute and chronic health effects of chemical insecticides on humans and other living beings, it is necessary to discover natural products against TMB as an alternative to chemicals. Lambda-cyhalothrin is the recommended chemical which is commonly used to manage TMB. Still, the negative impact of chemical pesticides on the environment and living organisms necessitates looking into alternative management measures, especially using plant-based natural products. With this intention, an experiment to evaluate the efficacy of some natural products against the Tea mosquito bug was conducted.

MATERIALS AND METHODS

The present study was carried out during 2019–2023 Kerala Agricultural University, Regional Agricultural Research Station, Pilicode, Kasaragod (13°N latitude, 75°E longitude; at an elevation of 15 m amsl), Kerala. Soil type was laterite with a pH of 5.5–6.5. The mean maximum temperature of the location was 33°C, and it has a mean minimum temperature of 23°C. The average annual rainfall in this region is 3379 mm (RARS 2025).

The cashew trees selected for the study were 20-years old and variety selected was Madakkathara 1, which is an early-flowering type. The treatments included spraying of T₁, Neem seed kernel extract (NSKE) 5% (aqueous extract); T₂, Kasargod dwarf cow urine 10%; T₃, *Vitex negundo* L. leaf extract (7.5 ml/litre of water); T₄, Bougainvillea leaf extract (10% solution); T₅, *Mesosphaerum suaveolens* (L.) Kuntze extract (5 % solution); T₆, Standard check-Lambda cyhalothrin @0.6 ml/litre of water as per Package of Practices (KAU 2024) recommendation; T₇, 'Aavya', a proprietary botanical formulation of Mr. Ajith Paul, Siliguri, West Bengal; and T₈, Untreated control. The extract of

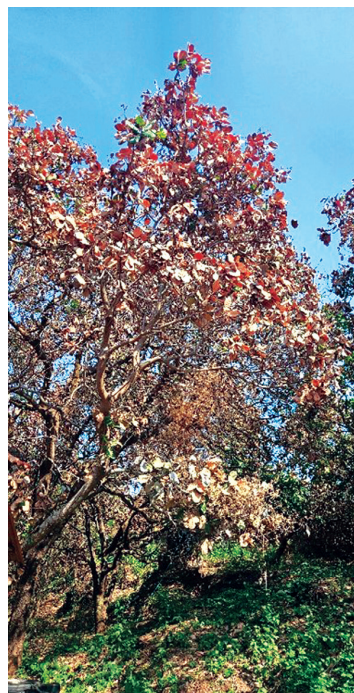


Fig. 2 Burnt-up appearance.

leaves (T₃, T₄, T₅) was prepared by taking the weight of leaves and grinding using a mortar and pestle and soaking in the required quantity of water.

The experiment was laid out in a randomized block design (RBD), with three replications and minimum of two plants/replication. The treatments were sprayed at 15-day intervals at flushing, flowering, and nut-setting stages, as the TMB attack is more prominent during these three stages. The observations were recorded on 7 days after spraying. A supplementary treatment

was given as per the recommendation of AICRP before the flushing stage in the 3rd and 4th year. Pre-treatment observations were also recorded. The damage done by TMB was assessed using the damage score rating technique provided by AICRP on cashew and was recorded from 52 leader shoots of each tree considering all sides of the tree canopy.

Damage score rating technique by AICRP on cashew, 0, No damage; 1, 1–3 necrotic streaks/lesions on the shoot/panicle including apple and nut; 2, 4–6 coalescing or non-coalescing lesions/streaks on the shoot/panicle including apple and nut; 3, Above six coalescing or non-coalescing lesions/streaks on the shoot/panicle including apple and nut; 4, Lesions/streaks confluent or wilting or drying of affected shoot/panicle including apple and nut.

$$\text{Mean score value} = \frac{\text{Total score}}{(\text{Total number of lateral shoots} + \text{panicles})}$$

The yield was documented at the time of each harvest. The data was analysed using statistical software ICAR CCARI WASP 2.0 and the results are presented below:

RESULTS AND DISCUSSION

Throughout the study period, all the trees under study had indistinguishable pre-treatment damage score before spraying. When the data was compiled for each spraying at the three vulnerable stages, viz. flushing, flowering, and nut setting the results were as follows. In 2019–20, at flushing stage, the lowest damage score was recorded with T₂, Kasaragod dwarf cows' urine treatments (2.10) and T₆, Lambda-cyhalothrin (2.16) (Table 1). Similar results were observed during other stages. Damage score at flowering was lowest in T₂ (2.08) and T₆ (2.14). During nut-setting, T₆

Table 1 Effect of different treatments on the incidence of TMB in cashew from 2019–2021

Treatment	2019–20				2020–21			
	Pre-treatment	Flushing	Flowering	Nut setting	Pre-treatment	Flushing	Flowering	Nut setting
T ₁ , Neem seed kernel extract	2.30 (1.52)	2.34 (1.53)	2.30 (1.52)	2.28 (1.51)	2.43 (1.71)	1.25 (1.31)	1.75 (1.49)	1.50 (1.40)
T ₂ , Kasaragod dwarf cows' urine	2.21 (1.49)	2.10 (1.45)	2.08 (1.44)	2.06 (1.44)	2.43 (1.71)	2.75 (1.79)	3.50 (2.00)	3.75 (2.06)
T ₃ , <i>Vitex negundo</i>	2.35 (1.53)	2.39 (1.55)	2.36 (1.54)	2.36 (1.53)	2.40 (1.70)	3.50 (2.00)	3.25 (1.92)	3.00 (1.86)
T ₄ , Bougainvillea leaf extract	2.29 (1.51)	2.31 (1.52)	2.28 (1.51)	2.23 (1.49)	2.40 (1.70)	2.50 (1.73)	3.00 (1.86)	2.00 (1.56)
T ₅ , <i>M. suaveolens</i>	2.36 (1.53)	2.40 (1.55)	2.39 (1.55)	2.39 (1.55)	2.43 (1.71)	2.50 (1.70)	2.75 (1.79)	2.25 (1.63)
T ₆ , Lambda-cyhalothrin	2.27 (1.51)	2.16 (1.47)	2.14 (1.46)	2.03 (1.42)	2.43 (1.71)	1.00 (1.23)	1.25 (1.31)	1.50 (1.40)
T ₇ , <i>Aavya</i>	2.31 (1.52)	2.38 (1.54)	2.30 (1.52)	2.35 (1.53)	2.38 (1.70)	3.75 (2.06)	3.00 (1.86)	3.50 (1.99)
T ₈ , Untreated control	2.28 (1.51)	2.33 (1.54)	2.33 (1.54)	2.33 (1.53)	2.46 (1.72)	3.25 (1.92)	3.25 (1.92)	3.75 (2.06)
F test	NS	**	**	**	NS	**	**	**
SE(m) ±	-	0.007	0.006	0.006	0.006	0.109	0.109	0.118
CD @ 5%	-	0.02	0.02	0.02	-	0.32	0.32	0.34
CV	1.71	0.97	0.81	0.86	0.69	12.68	12.35	13.51

TMB, Tea mosquito bug (AICRP damage score on shoots/inflorescences (0–4 scale) at 7 DAS). *Figures in parenthesis are square root transformed values.

(2.03) and T₂ (2.06) were having the best results. In 2020–21, at flushing stage, lowest damage score was observed with T₆ (1.00) and T₁, Neem seed kernel extract (1.25). At the time of flowering T₆-Lambda-cyhalothrin, was having lowest damage score but during nut-setting both T₆ and T₁ were on par and showed low damage score.

In 2021–22, after the extra spraying before flushing, significant differences between treatments were noticed regarding the damage score after spraying (Table 2). Before flushing stage, lowest damage score was observed with Lambda-cyhalothrin (1.75) followed by Neem seed kernel extract treatments (2.50) (Table 2). Similarly at flushing stage, a damage score of 1.00 was observed with T₆ which was the lowest, and was followed by T₁ treatment, which was on par with T₂ and T₄-Bougainvillea extract. During flowering stage T₆ (1.75) again had lowest damage score followed by T₁ (2.25). After spraying at the nut setting stage the lowest damage score was from T₁ (1.25) followed by T₆ spray.

In the final year of study, least damage score was observed with Lambda-cyhalothrin (2.34) followed by *Aavya* (2.75) and then Neem seed kernel extract treatments (3.00) (Table 2). T₆, Lambda-cyhalothrin (1.25) was showing the least damage at the time of flushing when spray was given, followed by T₇, *Aavya* (2.25) which was on par with T₁, NSKE treatments (2.50). During flowering stage, the lowest damage score was reported from Lambda, cyhalothrin treated trees, followed by T₅, *M. suaveolens* extract treatment.

During nut setting stage Kasaragod dwarf cows' urine treatment (1.50) and Lambda-cyhalothrin treatment (1.75) had the lowest damage score.

Throughout the study, lambda-cyhalothrin (T₆) consistently resulted in the lowest damage scores, indicating its high efficacy in managing TMB infestations. Makawana *et al.* (2017) also reported that in TMB endemic areas, throughout the most susceptible periods of attack in cashew consistent with flushing, flowering, and fruiting, it is best to spray Lambda-cyhalothrin (0.003%), Profenophos (0.05%) and Carbaryl (0.15), respectively. The effectiveness of lambda-cyhalothrin and other insecticides against TMB were studied by Naik and Chakravarthy (2013) and found that spraying Monocrotophos (0.05%)- Lambda-cyhalothrin (0.005%)-Carbaryl (0.10%) in sequence at flushing, panicle formation and nut setting was effective. The mean nut yield recorded during their study was highest (1106.57 kg/ha) in successive spraying of monocrotophos (0.05%)-Lambda-cyhalothrin (0.005%)-Carbaryl (0.10%) followed by serial spraying schedule of Monocrotophos (0.05%)-Endosulfan (0.05%)-Carbaryl (0.10%) (879.91 kg/ha). Our result corroborates with Jalgaonkar *et al.* (2009), aim to identify an alternative insecticide against Tea Mosquito Bug and found that out of the six treatments selected, lambda-cyhalothrin (0.003%) was notably superior to all other treatments. In another recent field study conducted to find out efficacy of insecticides against TMB, Lambda-cyhalothrin 5 EC sprayed @1.2 ml/litre was found to be the best treatment

Table 2 Effect of different treatments on the incidence of TMB in cashew from 2021–23

Treatment	2021–22					2022–23				
	Pre-treatment	Before flushing	Flushing	Flowering	Nut setting	Pre-treatment	Before flushing	Flushing	Flowering	Nut setting
T ₁ , Neem seed kernel extract	2.64 (1.64)	2.50 (1.72)	2.50 (1.72)	2.25 (1.65)	1.25 (2.50)	1.54 (1.43)	3.00 (1.87)	2.50 (1.70)	3.25 (1.92)	3.50 (2.00)
T ₂ , Kasaragod dwarf cows' urine	2.68 (1.65)	3.25 (1.93)	2.75 (1.79)	3.50 (2.00)	3.50 (2.91)	1.52 (1.42)	3.50 (2.00)	4.00 (2.12)	1.50 (1.40)	1.50 (1.40)
T ₃ , <i>Vitex negundo</i>	2.66 (1.65)	3.00 (1.86)	4.00 (2.12)	4.00 (2.12)	3.25 (2.87)	1.55 (1.43)	3.75 (2.06)	2.75 (1.76)	3.25 (1.93)	4.00 (2.12)
T ₄ , Bougainvillea leaf extract	2.68 (1.65)	3.00 (1.87)	2.75 (1.79)	3.00 (1.86)	2.50 (2.73)	1.74 (1.49)	3.75 (2.06)	3.75 (1.99)	3.75 (2.00)	3.25 (1.92)
T ₅ , <i>M. suaveolens</i>	2.70 (1.67)	2.75 (1.80)	3.00 (1.84)	2.50 (1.73)	2.25 (2.69)	1.72 (1.49)	3.25 (1.93)	4.00 (2.12)	1.25 (1.31)	2.75 (1.80)
T ₆ , Lambda-cyhalothrin	2.75 (1.67)	1.75 (1.49)	1.00 (1.23)	1.75 (1.48)	2.00 (2.64)	1.68 (1.48)	2.34 (1.69)	1.25 (1.31)	1.00 (1.23)	1.75 (1.49)
T ₇ , <i>Aavya</i>	2.56 (1.62)	3.25 (1.93)	3.75 (2.06)	3.50 (1.99)	3.25 (2.87)	1.65 (1.47)	2.75 (1.79)	2.25 (1.64)	3.50 (2.0)	3.25 (1.92)
T ₈ , Untreated control	2.68 (1.65)	3.75 (2.06)	3.25 (1.92)	3.50 (1.99)	3.50 (2.91)	1.73 (1.49)	3.50 (2.00)	2.75 (1.79)	3.25 (1.93)	3.75 (2.06)
F test	NS	**	**	**	**	NS	**	**	**	**
SE(m) ±	0.01	0.0001	0.12	0.11	0.08	0.03	0.07	0.15	0.08	0.09
CD @ 5%	-	0.20	0.36	0.33	0.24	-	0.21	0.43	0.24	0.27
CV	1.59	7.42	13.35	12.20	5.86	3.88	7.04	16.38	9.52	9.87

TMB, Tea mosquito bug (AICRP damage score on shoots/inflorescences (0–4 scale) at 7 DAS). *Figures in parenthesis are square root transformed values.

with the lowest percentage of infestation as recorded (4.18%) (Mande *et al.* 2021).

The neem and neem-based products affect the insect pests causing repellence, feeding deterrence, toxicity, sterility and inhibiting moulting and oviposition. On the other hand, they are bio-degradable products which are safe for the environment. In the present study, T₁, Neem Seed Kernel Extract (NSKE) was the most effective among the natural products, significantly reducing the TMB damage score, particularly in the second and third years. Similarly, a field experiment conducted by Manimaran *et al.* (2019), also had similar results where they tested the potency of bio-pesticides against TMB. The results of the experiment disclosed that mean number of tea mosquito bugs recorded per tree within a fortnight of treatment was lowest (1.53/tree) in the trees sprayed with *Azadirachtin* 10,000 ppm followed by those which were treated with NSKE 5% (1.93/tree). NSKE's repellent and toxic effects on TMB, as reported in previous studies (Dutta *et al.* 2013), likely contributed to its success in pest control. Further, studies have results encompassing the effect of neem products as a sustainable alternative to chemical insecticides, in terms of easiness in procuring the raw material, low-cost in manufacturing and ecologically favourable nature (Saroj *et al.* 2016). In another study of TMB in tea, Roy *et al.* (2010), found that the concentration of *Azadirachtin* in the spray determines

the effectiveness of neem against the targeted insect pest. The insecticidal action of *Azadirachtin* concentrations may also depend on different species of insect and 5% was perfect for obtaining the desired control of 60–65% of *H. theivora* at 1:200 in tea.

Kasaragod Dwarf Cow Urine (T₂), although showed some effect in the first year, was less consistent in subsequent years compared to NSKE and Lambda-cyhalothrin. *Vitex negundo* (T₃), Bougainvillea leaf extract (T₄), and *M. suaveolens* (T₅) were less effective than NSKE (T₁), but still showed some potential for pest management. These plant extracts have previously been noted for their insect-repellent properties but require further refinement for broader application. The treatment T₇ (*Aavya*) although promising in the 3rd and 4th years, did not showed results comparable to chemical controls like lambda-cyhalothrin or NSKE (T₁). Bhuyan *et al.* (2017) found that (56.41%) of the tea growers used cow dung and cow urine, followed by *Azadirachta indica* A. Juss. (48.71%), *Persicaria hydropiper* (L.) Delabre (43.58%) and Fish waste (30.78%) against tea mosquito bug in tea, when they studied the Indigenous technical knowledge used by tea growers in Assam. The potential of cow's urine was also studied by Patel *et al.* (2019). When a field experiment to assess the potential of combinations of bio-pesticides and cow urine was conducted in Anand, Gujarat, similar results were

Table 3 Effect of different treatments on the yield of cashew from 2019–23

Treatment	2019– 20	2020– 21	2021– 22	2022– 23
	Raw nut yield (kg/tree)			
T ₁ , Neem seed kernel extract	3.53 ^b	3.37 ^{bc}	3.52 ^b	3.52 ^b
T ₂ , Kasaragod dwarf cows' urine	2.49 ^{cd}	3.49 ^b	3.57 ^b	2.89 ^c
T ₃ , <i>Vitex negundo</i>	2.56 ^{cd}	3.05 ^{bc}	2.65 ^c	2.35 ^{cd}
T ₄ , Bougainvillea leaf extract	3.00 ^{bc}	2.89 ^{bcd}	2.66 ^c	2.78 ^c
T ₅ , <i>M. suaveolens</i>	2.64 ^{cd}	2.74 ^{bcd}	2.43 ^c	2.67 ^c
T ₆ , Lambda-cyhalothrin	4.57 ^a	4.92 ^a	4.68 ^a	4.33 ^a
T ₇ , <i>Aavaya</i>	2.41 ^{cd}	2.53 ^{cd}	2.45 ^c	2.37 ^{cd}
T ₈ , Untreated control	2.18 ^d	2.03 ^d	2.15 ^c	2.00 ^d
F test	**	**	**	**
SE(m) ±	0.28	0.404	0.293	0.254
CD @5%	0.601	0.869	0.629	0.546
CV	11.73	15.85	11.91	10.77

obtained. They used cow urine, in combination with neem oil 1% and NSKE 5% against insect pests of cotton. Among the treatments of cow urine and other bio-pesticides, cow urine as such (100%) in combination with neem oil 1% was significantly reducing the attack of cotton aphids, jassids and thrips in Bt cotton.

When the raw nut yield per tree was compared among treatments, it was found that there was significantly more production of nuts in T₆ where, Lambda-cyhalothrin was used for managing TMB throughout the study period (Table 3). However, NSKE (T₁) and Kasaragod Dwarf Cows' Urine (T₂) produced significantly higher yields than the untreated control, though they fell short of the chemical control. As reported by Raviprasad and Vanitha (2020) neem seed kernel extract causes mortality of TMB only to a level less than 50%.

While Lambda-cyhalothrin remains the most effective treatment for managing TMB in cashew, Neem Seed Kernel Extract (NSKE) is a viable organic alternative. Kasaragod Dwarf Cows' Urine and other plant extracts showed variable success, with NSKE emerging as the most consistent natural control method. This study supports the adoption of NSKE and cows' urine as a substitute to chemical insecticides, especially where farmers follow organic farming. However, further exploration is mandatory to discover new bio-pesticides and combinations of natural products in insect pest management.

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