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RESEARCH NOTE

Evaluation of biopesticides and insecticides against *Sciothrips cardamomi* Ramk.

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ABSTRACT: Cardamom thrips, *Sciothrips cardamomi* Ramk., is a major and persistent pest of small cardamom, *Elettaria cardamomum* (L.) Maton, causing significant yield loss in poorly managed plantations. The development of effective and sustainable management strategies is therefore essential. In the present study, four botanicals, namely neem seed kernel extract (NSKE) @ 5%, *Brugmansia suaveolens* (*Br. suaveolens*) leaf extract @ 5%, *Tithonia diversifolia* leaf extract @ 5%, and *Aloe* extract @ 2%; horticultural mineral oil @ 1%; two entomopathogenic fungi, *Lecanicillium lecanii* @ 2% and *Beauveria bassiana* (*B. bassiana*) @ 2%; and four insecticides, Spinetoram 11.7 SC, Thiamethoxam 25 WG, Quinalphos 25 EC, and Spiromesifen 22.9 SC, were evaluated against *S. cardamomi*. The results revealed that Spinetoram 11.7 SC recorded the lowest capsule infestation, followed by Thiamethoxam 25 WG, Quinalphos 25 EC, NSKE 5%, and Spiromesifen 22.9 SC during both dry and monsoon seasons. Significantly reduced capsule infestation was also observed in treatments with horticultural mineral oil, *B. bassiana*, and *Br. suaveolens* leaf extract. These findings indicate that, in addition to the proven efficacy of chemical insecticides and NSKE, horticultural mineral oil, *B. bassiana*, and *Br. suaveolens* possess considerable potential for incorporation into the integrated management programmes for *S. cardamomi*, following further validation and standardization under field conditions.

Keywords: Cardamom thrips, bio-efficacy, evaluation, bio-pesticides, insecticides

INTRODUCTION

Small cardamom, *Elettaria cardamomum* (L.) Maton, belonging to the family Zingiberaceae, is indigenous to the moist evergreen forests of the Western Ghats, southern India (Ravindran, 2002). Globally, India is the largest user and second in production and export of small cardamom (Kuruvila *et al.,* 2022). In India, the cultivation is concentrated in the three southern states viz., Kerala (exceeding 90% of the production), Karnataka, and Tamil Nadu (Ravindran, 2002; Murugan *et al*., 2009; Spices Board, 2024). Insect pests pose serious damage to the cardamom plantations and demand excessive insecticides to tackle them. Out of more than seventy reported insect pests (Gopakumar and Chandrasekar, 2002; Joshi *et al*., 2023; Nafeesa *et al*., 2025a, 2025b), the cardamom thrips, *Sciothrips cardamomi* Ramk. (Thysanoptera: Thripidae), is highly troublesome and enduring pest in cardamom production system (Gopakumar and Chandrasekar, 2002).

The feeding stages of *S. cardamomi*, comprising both nymphs and adults, damage cardamom plants by rasping and sucking sap from tender shoots and various panicle parts, including bracts, perianths, flower buds, peduncle, and immature capsules. Such feeding injury leads to the shedding of flowers and immature capsules, reduced capsule development, and the formation of characteristic scab-like lesions, commonly known as "itch," on mature capsules (Gopakumar and Chandrasekar, 2002; Ranjith and Krishnamoorthy, 2016; Venukumar *et al.,* 2018). *Sciothrips cardamomi* causes considerable economic damage, and the unprotected crop may suffer up to 80 percent damage (45-48% crop loss) (Gopakumar and Chandrasekar, 2002). In the Cardamom Hill Reserves (CHR), Kerala, the estimated pesticide consumption rate for managing this pest is 2.85 kg a.i. ha^{-1} per season (Murugan *et al.,* 2017). Frequency of pesticide application per year in the CHR system is also very high (three times more) compared to the recommended rate (KAU POP 2016, Kuruvila *et al*., 2022; Nafeesa *et al*., 2024).

Due to the severity of the pest and high value nature of the crop, an array of chemical insecticides were evaluated against *S. cardamomi* by various researchers. Even though some botanicals, biocontrol agents, and chemical pesticides were tested and recommended for the management of cardamom thrips, still unable to provide effective bio or chemical alternatives to manage *S. cardamomi* (Gopakumar and Chandrasekar, 2002; Josephrajkumar *et al.,* 2002; Stanley *et al*., 2014; Jacob *et al.,* 2015; Ranjith and Krishnamoorthy, 2016; Venukumar *et al.,* 2018; Kumar *et al.,* 2015, 2021; Nafeesa *et al.,* 2024). Even though Central Insecticide Board and Registration Committee (CIB & RC) approved only a few pesticides in cardamom system, nearly forty different chemical formulations are widely adopted for pest control in the Cardamom Hill Reserves, Kerala (DPP, QS, 2023; Kuruvila *et al*., 2022). Many ineffective chemicals with high dosages enter the system in place of effective chemicals with right dosages (Nafeesa *et al*., 2024). Hence, deliberate efforts are required to address this issue and to formulate bio and chemical strategies to manage *S. cardamomi.* Under these circumstances, this study was designed and executed to evaluate botanical extracts, horticultural mineral oil, entomopathogenic fungi and chemical pesticides against *S. cardamomi.*

MATERIALS AND METHODS

The study was carried out during 2022–23 at the farm of the Cardamom Research Station (CRS), Pampadumpara, Kerala, India (9.79847° N, 77.16127° E). The experiment comprised twelve treatments, namely neem seed kernel extract (NSKE) @ 5%, *Brugmansia suaveolens* ((*Br. suaveolens*)) leaf extract @ 5%, *Tithonia diversifolia* leaf extract @ 5%, *Aloe* extract @ 2%, horticultural mineral oil (HMO) @ 1%, the entomopathogenic fungi *Lecanicillium lecanii* @ 2% and *Beauveria bassiana* @ 2%, and the insecticides Spiromesifen 22.9 SC @ 7 ml/10 L, Spinetoram 11.7 SC @ 4 ml/10 L, Thiamethoxam 25 WG @ 2 g/10 L, and Quinalphos 25 EC @ 20 ml/10 L, along with an untreated control. Each treatment was replicated three times in a Randomized Block Design (RBD). The study was conducted on seven-year-old cardamom plants of the variety 'Green Gold'. Chemical pesticides were procured from the local pesticide dealers. EPF dust formulations were purchased from the biocontrol laboratory, CRS, Pampadumpara, and botanicals were freshly prepared in the lab. All other crop management practices including fertilizer application and irrigation were done as per the Kerala Agricultural University's POP (2016).

Pesticide sprays were scheduled seven times (four sprays from January to May at monthly intervals and three from August to December during the dry spells of the monsoon period) according to the KAU POP (2016). In each treatment, six plants were maintained, and three plants were marked as observational plants. Year-round field observations were made at monthly intervals. Assessment of the infestation was based on the methodologies given by Joseph Rajkumar *et al*. (2002) and Jacob *et al.* (2015), with slight modifications. Ten panicles were randomly selected from each plant, and the damage symptoms were recorded. The observations, viz., number of infested panicles, total number of capsules in the ten selected panicles, and number of infested capsules (capsules with 'itch'/scab), were noted from the field. Percentage of infested panicles and capsules was calculated using the formula given below.

$$\text{Panicles infested (\%)} = \frac{\text{Number of panicles infested}}{\text{Total number of panicles counted}} \times 100$$

$$\text{Capsules infested (\%)} = \frac{\text{Number of capsules infested}}{\text{Total number of capsules counted}} \times 100$$

Observation from four harvests were taken during the experiment period. The weight of the harvested green capsules and the percentage of infestation on 100 randomly selected capsules were recorded in each treatment in all replications. The data thus obtained were subjected to ANOVA, and all statistical analyses were done using the Statistical Packages WASP (Jangam and Thali, 2004) and grapes Agri1 (Gopinath *et al*., 2021).

RESULTS AND DISCUSSION

The results given in Table 1 show that the treatment means were significantly different among the variables. From the year-round observations, the percentage of panicles that shown visible symptoms of infestation was lowest in cardamom plants treated with Spinetoram 11.7 SC, followed by Thiamethoxam 25 WG, Quinalphos 25 EC, NSKE 5%, Spiromesifen 22.9 SC and HMO. Reduction in panicle infestation was also recorded in plants treated with *B. bassiana* and *Br. suaveolens* over the control (water spray). According to the field count and the observations recorded on harvested capsules, plants treated with Spinetoram 11.7 SC had the lowest percentage infestation on capsules. Thiamethoxam 25 WG, Quinalphos 25 EC, NSKE 5%, and Spiromesifen

Table 1: Infestation percentage of cardamom thrips, *Sciothrips cardamomi* after the application of botanicals, EPF and chemical pesticides in small cardamom

Treatment	Pre count		Field observations after treatment				Wet capsule yield per treatment (kg)	% of capsules infested in harvested capsules
			Rainless period (Jan – May)		Monsoon period (Jun – Dec)			
	% of panicles infested	% of capsules infested	% of panicles infested	% of capsules infested	% of panicles infested	% of capsules infested		
NSKE 5 %	44.44 (41.76)	34.14 (35.73)	41.33^{de} (39.94^{de})	25.41^{cdef} (30.08^{cde})	48.25^{bc} (43.93^{bc})	33.85^{d} (35.49^{d})	2.193	49.92^{c} (44.95^{c})
Br. suaveolens (Leaf extract) 5 %	57.78 (49.57)	39.62 (38.99)	52.22^{bc} (46.28^{bc})	32.57^{bc} (34.79^{bc})	55.56^{ab} (48.23^{ab})	43.45^{bcd} (41.23^{bcd})	2.823	58.42^{bc} (49.85^{bc})
T. diversifolia	61.11 (51.67)	43.55 (41.29)	54.00^{b} (47.31^{b})	35.95^{ab} (36.84^{ab})	60.00^{ab} (51.03^{ab})	44.36^{bc} (41.76^{abcd})	3.767	59.83^{ab} (50.70^{ab})
Aloe extract	63.33 (52.85)	37.30 (37.63)	55.34^{b} (48.08^{b})	36.16^{ab} (36.89^{ab})	62.54^{ab} (52.62^{ab})	45.99^{abc} (42.69^{abc})	4.027	60.08^{ab} (50.90^{ab})
HMO	52.22 (46.28)	36.26 (37.02)	44.22^{cde} (41.56^{cde})	31.19^{bcd} (33.91^{bcd})	56.51^{ab} (48.77^{ab})	40.22^{bcd} (39.33^{bcd})	3.783	55.25^{bc} (48.01^{bc})
L. lecanii	55.56 (48.25)	35.21 (36.35)	56.00^{b} (48.47^{b})	36.05^{ab} (36.90^{ab})	62.06^{ab} (52.49^{ab})	47.95^{ab} (43.77^{ab})	3.140	61.50^{ab} (51.67^{ab})
B. bassiana	52.22 (46.28)	34.51 (35.95)	49.56^{bcd} (44.75^{bcd})	31.76^{bcd} (34.27^{bc})	60.64^{ab} (51.20^{ab})	39.84^{bcd} (39.13^{bcd})	3.320	57.00^{bc} (49.06^{bc})
Spiromesifen 22.9 SC	58.89 (50.89)	37.27 (37.61)	44.67^{cde} (41.92^{cde})	30.32^{bcde} (33.41^{bcd})	55.24^{ab} (48.05^{ab})	35.77^{cd} (36.70^{cd})	3.443	53.75^{bc} (47.15^{bc})
Spinetoram 11.7 SC	61.11 (51.42)	37.25 (37.59)	37.78^{e} (37.91^{e})	16.97^{f} (24.30^{f})	33.81^{c} (35.45^{c})	15.37^{e} (23.07^{e})	4.993	24.42^{e} (29.58^{e})
Thiamethoxam 25 WG	42.22 (40.48)	32.05 (34.24)	38.00^{e} (38.02^{e})	22.07^{ef} (27.82^{ef})	33.97^{c} (35.61^{c})	16.61^{e} (23.93^{e})	3.937	33.92^{d} (35.59^{d})
Quinalphos 25 EC	40.00 (39.09)	30.23 (33.23)	40.22^{e} (39.31^{e})	23.38^{def} (28.72^{def})	46.03^{bc} (42.62^{bc})	22.66^{e} (28.14^{e})	4.960	36.75^{d} (37.09^{d})
Control Water spray	62.22 (52.61)	35.82 (36.72)	70.00^{a} (56.80^{a})	41.97^{a} (40.37^{a})	71.90^{a} (58.26^{a})	55.20^{a} (48.05^{a})	3.993	68.75^{a} (56.06^{a})
CV	21.41 (14.94)	16.42 (9.76)	10.97 (7.07)	16.67 (9.876)	19.61 (13.39)	16.78 (10.26)	29.15	10.45 (7.07)
CD (0.01)	ns	ns	12.28 (7.19)	11.63 (7.54)	24.32 (14.59)	14.21 (8.72)	ns	12.41 (7.46)
CD (0.05)	ns	ns	9.03 (5.29)	8.56 (5.55)	17.89 (10.73)	10.45 (6.42)	ns	9.13 (5.49)
SE(d)	9.48	4.84	4.36	4.13	8.63	5.04	0.88	4.40

In a column, treatment means followed by different letters are significantly different otherwise non-significant.
Values in parentheses are arc sine transformed values.

22.9 SC were next in line. In addition to the above treatments, thrips infestation on capsules was lower on plants treated with HMO, *B. bassiana,* and *Br. suaveolens,* and in most of the variables, these treatments were on par with one another. Variations were recorded on the weight of the harvested capsules under different treatments.

In all of the variables examined, plants treated with Spinetoram 11.7 SC showed the lowest percentage of *S. cardamomi* infestation symptoms. Even though the variations in the average yield of different treatments was not significant, highest average yield was reported from the plants treated with Spinetoram 11.7 SC. Uniform and recommended fertilizer application and irrigation scheduling throughout the experiment period may be one of the reasons for the insignificant variation in yield among the treatments. The efficacy of spinetoram against different thrips species was detailed by various researchers in different annual and perennial agroecosystems (Walter *et al*., 2018; Guruprasad *et al*., 2019; Manideep *et al*., 2023). As per the Pesticides Fact Sheet (2009), spinetoram has been categorized under category IV, having low acute toxicity. This pesticide, which is widely used by cardamom farmers in different states (Manusha *et al.,* 2022; Kuruvila *et al*., 2022), does not have a label claim for cardamom. Of the tested pesticides, Thiamethoxam 25 WG and Quinalphos 25 EC have recorded considerable reduction in thrips infestation, and on par with the Spinetoram 11.7 SC. Previous studies have supported the effectiveness of thiamethoxam against the members of the genus *Sciothrips* and other thrips species (Venukumar *et al*., 2018; Manideep *et al*., 2023).

In this experiment, NSKE @ 5% had a desirable reduction in pest infestation in all of the tested variables, next to the above three chemicals, but numerically, the average yield was the lowest for this treatment. Both positive and negative results were recorded for neem-based formulation against *S. cardamomi* (Josephrajkumar *et al*., 2002; Stanley *et al*., 2014). Other than the chemical pesticides and NSKE, plants treated with HMO, *B. bassiana*, and *Br. suaveolens* showed a significant reduction in *S. cardamomi* infestation in all of the tested variables. The potential of HMO to reduce the population of other thrips species was given by researchers (Xue *et al.,* 2002; Singh *et al*., 2020).

The entomopathogenic fungus *B. bassiana* has been tested on a number of pest species and is widely used in biocontrol strategies worldwide (Boaria *et al.,* 2011). A number of scientific experiments that proved the effectiveness of *B. bassiana* against various thrips species under many agro ecosystems (Boaria *et al.,* 2011; Goa *et al.,* 2012; Zahn *et al.,* 2013; Ain *et al.,* 2021). But it was neither studied in detail nor exploited in the cardamom production system against *S. cardamomi* (Gopakumar and Chandrasekar, 2002; Dhanya *et al.,* 2019; Nafeesa *et al.,* 2024). Kumar *et al.* (2015, 2021), isolated *L. psalliotae* from cardamom thrips and confirmed its infectivity and effectiveness both in the laboratory and field conditions. *Br. suaveolens* is an invasive plant species recorded from the Idukki district of Kerala (Sankaran *et al*., 2013) and is widely distributed in the CHR. The insecticidal property of *B. suaveolens* was discussed by Pundir *et al*. (2022). As per our results, plants treated with 5% leaf extract of *B. suaveolens* secured lesser thrips infestation in panicles and capsules.

CONCLUSION

Based on the results of the present study, Spinetoram 11.7 SC was the most effective treatment against *S. cardamomi*, recording the lowest infestation of panicles and capsules and the highest capsule yield. Among the non-chemical treatments, NSKE @ 5%, horticultural mineral oil (HMO), *B. bassiana*, and *Br. suaveolens* leaf extract showed promising efficacy in reducing pest incidence. Further studies on the standardization of dosage, formulation, and application methods are warranted to enhance their field efficacy and facilitate their wider adoption in cardamom production systems.

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AUTHORS CONTRIBUTIONS

The authors, MN and MM conceived the experiment, performed the field evaluation, analyzed the data and prepared the initial draft of the manuscript; MNI and JSR provided literature and revised the manuscript; D & KK assisted in field evaluation and data analysis. All authors read and approved the manuscript.

CONFLICT OF INTEREST

Declare no conflict of interest among the authors.

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