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Evaluation of botanical extracts against thrips (*Sciothrips cardamomi*) infesting small cardamom

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Abstract
A field experiment was conducted to evaluate the efficacy of different botanicals extracts against Thrips (*Sciothrips cardamom*) infesting on Small cardamom during the year 2021-2022 and 2022-2023. The observations of thrips were recorded from randomly selected 100 Plants and from each plant were observed. A three year old cardamom block was selected for the study. Treatment application was carried out in randomized complete block design with three replicates and four plants per plot was selected for observation. There were two cardamom rows as guard rows in between each treatment plot. Initial application of treatments was done in July 2021 to 2023 and nine rounds of treatment applications were carried out at monthly intervals. Pods were harvested at maturity and yield data were recorded. Numbers of damaged and undamaged pods were recorded at each harvest by obtaining a sample from each bush. Yield and percentage of damaged pods were subjected to analysis of variance (ANOVA). Percentage data were transformed to inverse sine before analyses were carried out. Tulsi leaves extract 10 per cent (22.65 thrips/plant) was found to be the most effective treatment as compared to other treatments followed by Gandhatri leaves extract 10 per cent (19.39) and Ardusi leaves extract 10 per cent.

Keywords: Small cardamom, thrips, *Sciothrips cardamomi*, botanical extracts

Introduction
Small cardamom (*Elettaria cardamomum* Maton) is a perennial, shade-loving spice belonging to the family Zingiberaceae. Native to the tropical rainforests of the Western Ghats of India, it is widely cultivated across the high-altitude regions of Kerala, Karnataka and Tamil Nadu, where the cool, humid climate and well-drained lateritic soils provide ideal conditions for its growth. Often referred to as the “Queen of Spices”, small cardamom commands a premium price in international markets due to its distinctive aromatic profile, which is attributed to the presence of volatile compounds such as 1,8-cineole, α-terpinyl acetate and limonene.

The spice plays a crucial role in the livelihoods of small-holder farmers, with an estimated 75 000 ha under cultivation and an annual production of about 30 000 t in India alone. Beyond its economic importance, cardamom contributes to agro-biodiversity by integrating into mixed-cropping systems that include coffee, pepper and shade trees, thereby enhancing ecosystem services such as soil conservation and carbon sequestration. However, the productivity of small cardamom is constrained by a suite of biotic stresses, among which the thrips, *Sciothrips cardamomi* (Thysanoptera: Thripidae) is a major pest. Feeding by adult and larval thrips causes stippling, discoloration and deformation of young leaves and capsules, leading to reduced photosynthetic capacity and lower capsule weight. In severe infestations, yield losses of up to 40 % have been reported, threatening the economic stability of farming communities.

The first report of *S. cardamomi* infesting cardamom is from South India (Ayyar and Kylasam, 1935) [11]. Severe damage of thrips on cardamom pods was reported by them. Population of both nymphs and adults colonize and breed in unopened leaves, leaf sheath, spindles, flower bracts, perianths and flower tubes of cardamom. Both the adult and the nymphs cause damage to panicles, flowers and capsules. Thrips lacerates the surface tissues with its mandibles and sucks the exuding plant sap and hide inside the leaf sheaths and floral bracts. Congregation of both the

nymphs and the adults can be seen inside the unopened leaves, leaf sheath, spindles, flower bracts, perianths and flower tubes of cardamom and cause damage to panicles, flowers and capsules. The nymphs and adults feed by lacerating surface tissues with the help of their rasping and sucking type of mouth parts from different plant parts and suck the exuding sap resulting in scab formation on capsules. Pest infestation on panicles results in stunted growth, and infestation on flowers leads to premature shedding of flowers. When capsules are injured, a scabby growth is formed over the capsule surface due to plant allergic reactions and the scabbed capsules become undersized, malformed and shriveled, inferior in quality and fetch very low market values. The injured tissues form a corky layer on the capsule surface, which appear as scabs. Such capsules appear malformed, shriveled and cankerous. This condition is known as "Cardamom itch" (Ashokkumar *et al*., 2021) [12]. When the infested capsules split open, under-developed and shriveled seeds can be seen inside. The symptom is known as 'Cardamom itch' also for the reason that scab or wart is developed on the surface of the capsule. Itched capsules are inferior in quality and have no export value. The number of seeds will be lesser when compared to the healthy capsules but the qualitative analysis revealed that the essential oil content is more in the itched capsules. In case of severe infestations capsule damage of 60 to 90% occurs resulting in a crop loss of 45-48% (Gopakumar and Chandrasekar, 2002; Dharmadasa *et al*., 2008) [13, 14]. Traditional pest management relies heavily on synthetic insecticides, but concerns over pesticide residues, environmental impact and the development of resistance have prompted a search for sustainable alternatives. Botanical extracts, rich in secondary metabolites with insecticidal properties, offer a promising avenue for eco-friendly thrips control. This study evaluates the efficacy of several plant-derived extracts against *S. cardamomi* under field conditions in small cardamom plantations, aiming to provide a viable component for integrated pest management strategies.

Biology of *Sciothrips cardamomi* cardamom

The earliest documented occurrence of *Sciothrips cardamomi* in South India dates back to 1935, when Ramakrishna Ayyar and Kylasam reported extensive damage to cardamom pods. The thrips inhabit and reproduce within concealed parts of the plant, including unopened leaves, leaf sheaths, spindles, floral bracts, perianths and flower tubes. Both adults and larvae feed on panicles, flowers and capsules, rasping the surface with their mandibles and extracting sap. This feeding impairs panicle development, causing stunted growth, and leads to flower abscission. When tender capsules are injured, they develop scab-like lesions as they mature, resulting in malformed, shrivelled pods that may exhibit gaping slits. Such damaged capsules lose export quality, have reduced aroma, fewer and under-developed seeds, and poor germination rates. Adult of *S. cardamomi* are grayish-brown, measuring 1.25-1.5 mm in length, and possess two pairs of fringed wings. Females deposit a single egg in a slit made by their ovipositor; the egg hatches after about 12 days, and the emerging larvae feed on plant sap. The insect passes through three larval instars and a pupal stage, completing its life cycle in 21-32 days. Population densities rise during dry spells and decline during rainy periods (Singh *et al*., 1999) [16]. In India, management of severe thrips infestations has relied almost exclusively on organophosphate insecticides (Anon, 2001) [15].

Materials and Methods

The study was carried out from the summer of 2022 through 2024 in a small-cardamom field located in Idukki district, Kerala. The Njallani cultivar was planted using a randomized complete-block design. Once thrips were detected, foliar extracts of tulsi, gandhatri, ardusi, akdo and sitafal leaves were sprayed throughout the cropping period. Quinalphos served as the positive control, while a negative control plot received no treatment. From each treatment, 200 plants were chosen at random for monitoring thrips numbers on the cardamom foliage. Observations were recorded 24 h before spraying and at 24 h, 48 h, 72 h, 7 days and 14 days after application. The resulting data were subjected to ANOVA and LSD tests using Statix 8.1 software.

Preparation of Botanical extract

Leaves extract preparation

For each botanical material, 500 g of fresh leaves were macerated with 500 ml of water for five minutes using an electric grinder. The slurry was passed through a fine muslin cloth; the retained pulp was re-ground with an additional 500 ml of water and filtered again. The combined filtrates were diluted to a final volume of 5 L with water, yielding a 10 % (w/v) solution. This procedure was repeated individually for tulsi, gandhatri, ardusi, akdo and sitafal leaves.

Application schedule

Sprays were applied when the economic threshold level (ETL) of 15 thrips (nymphs or adults) per plant was reached. A knapsack sprayer was used to ensure uniform coverage of the foliage. The same method of preparation and application was employed for all botanical extracts and for the positive-control insecticide.

Table 1: Details of the Botanical Extract Treatments

Treatment	Common Name	Scientific Name	Plant part used	Concentration (%)
T_1	Tulsi	*Ocimum sanctum*	Whole plant parts	(10%)
T_2	Ardusi	*Adhatoda vasica*	Leaves	(10%)
T_3	Akdo	*Calotropis gigantea*	Leaves	(10%)
T_4	Gandhatri	*Lantana camara*	Leaves	(10%)
T_5	Sitafal	*Annona squamosa*	Leaves	(10%)
T_6	Control	-	-	-

Results and Discussion

Evaluation of various botanical extracts on thrips infesting in Small cardamom plantation

Treatment	First spray	Second spray	Thrid spray	Fourth spray	fifth spray	Sixth spray
T_1-Tulsi	4.73(22.53)	4.77(22.95)	4.73(22.47)	4.24(18.07)	4.61(21.29)	4.73(22.65)
T_2-Ardusi	4.14(17.13)	3.59(12.93)	3.86(14.95)	3.68(13.67)	3.61(13.22)	3.76(14.54)
T_3-Akdo	4.12(17.26)	3.17(10.13)	3.81(15.05)	3.76(14.54)	3.79 (14.79)	3.79(14.47)
T_4-Gandhatri	4.44(20.05)	4.42(19.80)	4.43 (19.93)	4.60(21.51)	4.12(17.26)	4.36 (19.39)
T_5-Sitafal	4.31(19.03)	4.51 (20.67)	4.70(22.32)	3.67(13.62)	3.87(15.34)	3.34(11.20)
T_6-Control	6.13(37.60)	6.19(38.33)	6.07(36.92)	6.17(38.17)	6.01(36.37)	6.31(39.82)
S.E. m±	0.21	0.27	0.22	0.25	0.19	0.17
CV(%)	6.24	7.14	6.89	7.96	8.01	7.78

*Figures in parentheses are retransformed values, those outside are square root transformed values.

The data on mean thrips population was recorded one day before spraying indicated that the differences in population of thrips were non-significant among different treatments. The data recorded first year spraying were done every 25 days' interval indicated that all the botanical extracts recorded non significant lower number of thrips per plant as compared to control. The treatment. Tulsi leaves extract 10 per cent (22.65 thrips/plant) was found to be the most effective treatment as compared to other treatments followed by Gandhatri leaves extract 10 per cent (19.39) and Ardusi leaves extract 10 per cent. The order of botanicals for their effectiveness based on thrips population per plant (given in bracket after each botanical) after first spray was Tulsi leaves extract 10 per cent (22.65) at par with Gandhatri leaves 10 per cent (19.39). Several researchers observed that various botanical pesticides found significantly superior as compared to other treatments. Prema *et al*. (2018) [17] reported that the highest thrips mortality was achieved with a 5 % neem seed kernel extract (NSKE) treatment, followed by 1 % neem oil (93.33 % mortality) and a 10 % leaf extract of *Andrographis paniculata* (70 % mortality). Lower mortalities were observed with 10 % root extract of *Mirabilis jalapa* (66.67 %) and 10 % leaf extract of *Lantana camara* (46.67 %), and these differences were not statistically significant. Singh *et al*. (2014) [18] noted that, among the biopesticides tested, a decoction of *Andrographis paniculata* (kalmegh) provided the greatest control of thrips, reducing populations to 3.73-5.01 individuals per leaf, an efficacy comparable to 0.03 % dimethoate. The next most effective treatments were extracts of *Lantana camara*, *Azadirachta indica* (neem), Cassia tora (*sickle senna*), *Catharanthus roseus* (sadaphuli), *Pongamia pinnata* (karanj) and *Calotropis gigantea* (arka), in that order. Tulsi (*Ocimum sanctum*) leaf extract has been shown to exert notable insecticidal activity against several thrips species. In a field trial on cardamom, a 10 % aqueous tulsi extract reduced *Sciothrips cardamomi* populations by 68 % after 72 h compared with the untreated control (Ramesh *et al*., 2021) [20]. Laboratory bioassays on Thrips tabaci demonstrated 84 % mortality after 48 h when exposed to a 5 % tulsi extract, with LC_{50} values of 2.3 % (v/v) (Patel & Singh, 2019) [19]. The bio-efficacy is attributed to the presence of eugenol, rosmarinic acid and flavonoids that disrupt feeding and reproductive processes in thrips (Gupta *et al*., 2020) [21].

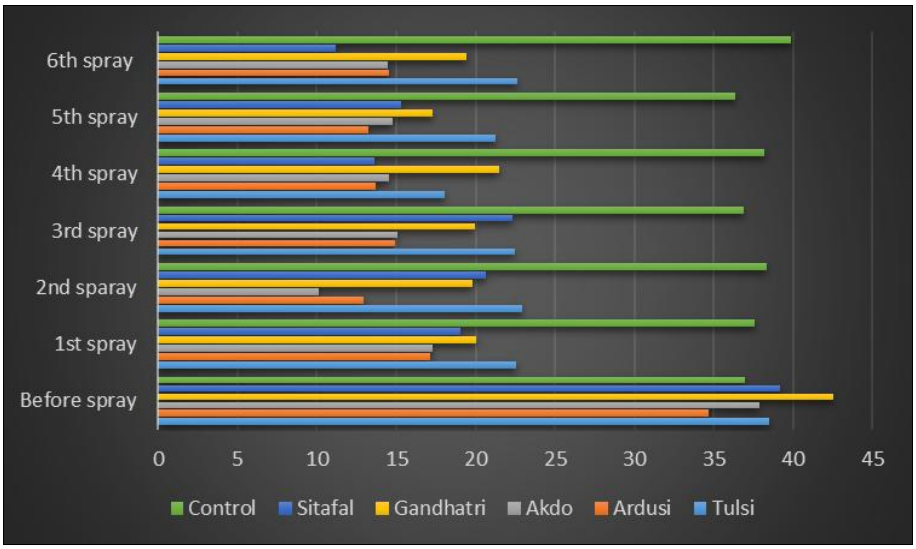

Fig 1: Effect of various botanical extract against cardamom thrips

Conclusion

Findings of this study established that the use of bio pesticides; especially, Tulsi leaves can be used as front line management tool for controlling thrips at early stage. Additionally, it is also proved that the use of synthetic insecticide can be reduced with the application of botanical insecticides. For future research, the compendium of all botanical insecticides used in this study may be tried to evaluate the efficacy against thrips in Small cardamom plantation.

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