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Survey on Indigenous Botanicals used by Tea Planters for Control of Pests and Diseases of Tea, *Camellia sinensis* (L.) O. Kuntze in the North Bengal Region, India

***Abstract*: Tea crop protection is an essential component of tea cultivation to safeguard tea plants from damage by pests, diseases, and other disorders. Tea plantations in North East India use a several-fold higher quantity of pesticides per hectare for control of pests than the Indian average of 500g/ha[1]. Therefore, there is a need to develop alternative pest control methods to boost the production and quality of tea. The present work is an attempt to document the plants used in the bioformulations against pests and may be the first-ever report of this kind from North Bengal, India.**

Keywords: Botanicals, Indigenous Technical Knowledge, Survey, Pest repellent plants, Integrated pest management

Tea is the most widely consumed drink after water in the world. India is the second-largest producer of Tea in the world after China[2]. It is an economically important crop in India and supports the livelihood of 1.5 million skilled workers and their dependents. Tea is a semi-perennial crop grown in India that yields about 1343.06 million kg per year (https://www.financialexpress.com/economy/tea-production-in-2022). The pests and diseases, causes 30 – 50% loss in production; so to prevent losses due to pests, pesticides have been recommended by Plant Protection Code (PPC). Despite control, loss of as much as 20% of crop occurs whereas without control losses could be as high as 50%[3]. This has led to the rampant use of pesticides in tea gardens which has compromised the quality as well as the health of workers.

The use of pesticides in controlling pests is as old as agriculture itself and it dates back to way before 2000 BC in ancient China, Egypt, Greece, and India. Crude botanical pesticides have been used for ages and are well-known in tribal and traditional societies all across the world[4]. There have been mentions of poisonous herbs being used in controlling pests in Rig Veda[5]. India appears to be more open to botanicals than many other countries in the region, allowing different botanical materials such as Pyrethrum, Rotenone, Neem, Essential oils, Ryania, Nicotine, and Sabadilla. The use of botanicals was sidelined after the introduction of Synthetic insecticides and significantly pushed botanicals from an essential role in agriculture to a practically negligible position in the marketplace among crop protectants, as evidenced by recent history[6]. However, the continuous use of pesticides results in the degradation of soil, the quality of tea, the emergence of resistant pests, etc. At least 720 insect and mite species are reported to be infested with tea and these are resistant to one or more pesticides[7]. Another major impact was the residue problem in tea, which hampered the export of tea and posed health concerns to consumers.

Darjeeling tea is a legendary brand that is popular in the international market because of its unique aroma and flavor and the cultivation is restricted to North Bengal. The maintenance of international standards or MRL is vital for the effective export and marketing of this variety[8]. This region has contributed substantially to the production and export of tea from our country. Dooars and Terai use the maximum quantity of pesticides per hectare which is plausible because the weather in these regions is very conducive to recurrent pest incidence. The annual requirement of pesticides in Dooars and Terai of North Bengal is 16.75 kg/L per hectare and the annual requirement of Darjeeling was 7.35 kg/L per hectare[9]. Dooars and Terai use the highest quantities of pesticides, which may pose a threat to the quality control and export of tea. Moreover, Terai and Dooars flaunt a workforce of about 3.5 lakh permanent workers, 52% of which are women and the use of pesticides will be detrimental to the health of these workers. This calls our attention to the revival of the age-old use of botanical formulations instead of the use of synthetic chemical pesticides against pests.

Terai and Dooars regions have rich floristic diversity and the occurrence of some poisonous and medicinal

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weeds from North Bengal has been reported[10]. Of these, *Melia azedarach* L., *Vitex negundo* L., and *Urtica dioica* L. have pest-controlling activity according to the list of 24 native plant species published in 'Indigenous herbs with potential for Tea pest Management'[11]. The PPC 2019 makes mention of Azadirachtin, an oxygenated triterpenoid compound obtained from the seed kernels of *Azadirachta indica* A. Juss. being effective against pink and purple mites and some caterpillars. It also mentions the aqueous extracts of certain commonly found herbs such as *Clerodendrum viscosum* Vent., *Vitex negundo* L., *Polygonum hydropiper* L., *Cassia tora* L., and *Xanthium strumarium* L. exhibiting promising control over most of the mite pests, insect pests, and diseases of tea. The objective of our work is to acquire information on the indigenous botanical formulations used against pests in tea gardens in the Dooars and Terai regions. This survey-based work is one of the pioneering studies of this kind from this region.

Methods: **Survey Area:** The primary data on pest control techniques used by Tea planters of Dooars and Terai were collected during periodical visits to gardens during the month of March to May 2022. The five tea gardens were visited and the data was collected from the interview with estate managers, workers, and other stakeholders. The gardens visited under this present study were Gayaganga T.E, Dagapur T.E, Mohurgong and Gulma T. E, New Dooars T.E and , Debpara T. E of North Bengal. The map of the study area is given in figure 1.

Results and Discussion: The data obtained from the survey indicates that tea growers are looking forward to including the long-lost concept of botanicals as an alternate way of controlling pests (Table 1). During our interaction with the tea-growing community including those who have lived there for generations, it is learned that around 30% - 70% control could be achieved through the usage of botanical formulations as alternative means of pest control. The plants of the bio formulations that were common in the studied tea gardens are *Justicia adhatoda* L., *Clerodendrum viscosum* Vent., *Vitex negundo* L., *Polygonum hydropiper* L., and *Melia azedarach* L. (Figure 2). Of these, *Justicia adhatoda* L. is used as a hedge and

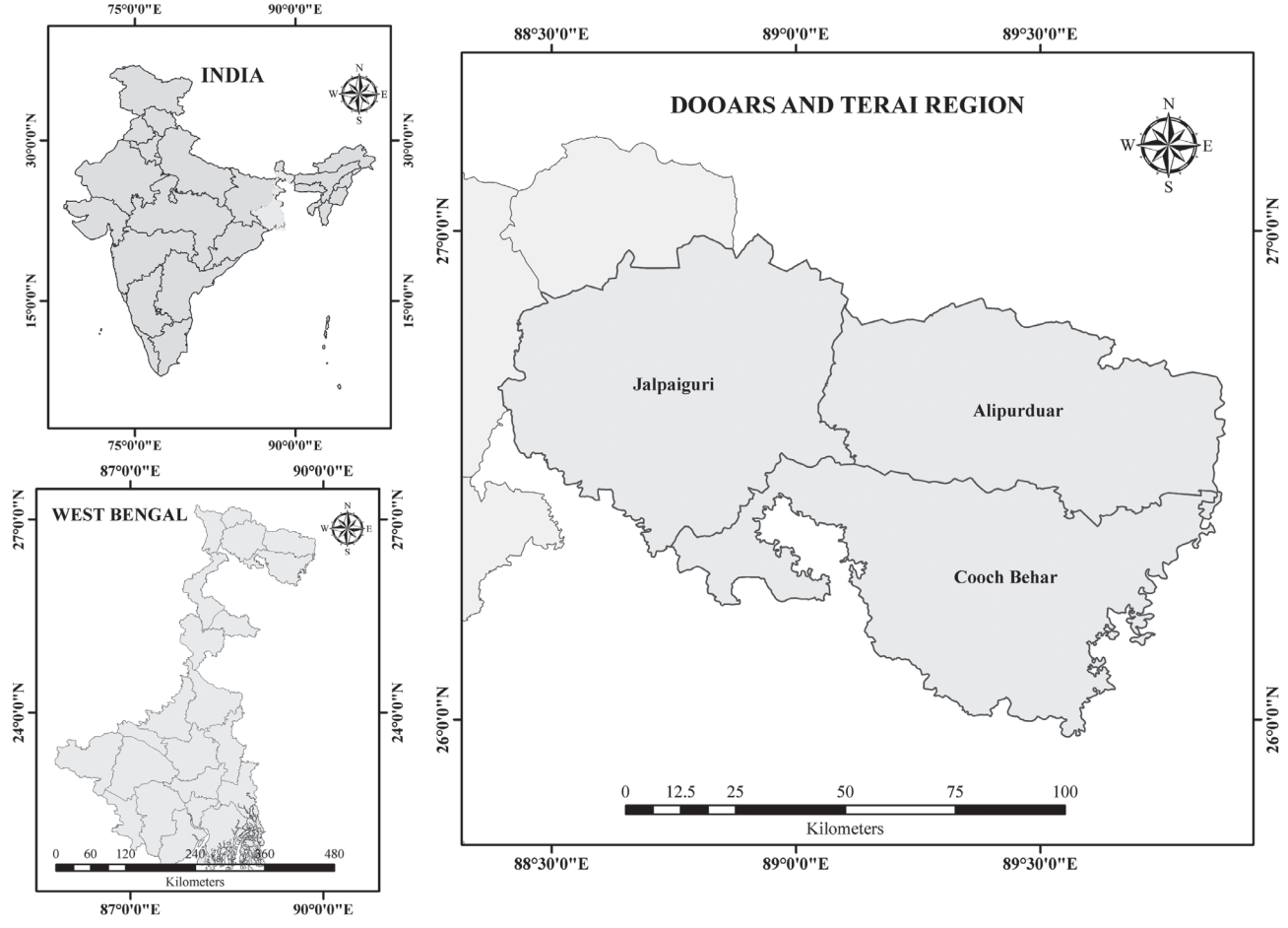

Fig. 1: Map of the Survey Region for the Study

Table 1: List of plants used in the bioformulations of different tea gardens of North Bengal

Garden name	Ecoregion	Geographical coordinate	Plants used	Target pests
Gayaganga T.E	Terai	26.6101° N, 88.3037° E	*Millettia Pinnata* (L.) Panigrahi	Looper Control
			Polygonum hydropiper L.	Looper Control
			Moringa oleifera Lam.	Looper Control
			Calotropis gigantea L.	Looper Control
			Tithiona diversifolia (Hemsl.) A. Gray	Tea mosquito bug
			Argemone mexiciana L.	Tea mosquito bug
			Aspidium felix mas (L.) Sw.	Red spider mite
			Vitex negundo L.	Red spider mite
			Melia azedarach L.	Sucking insect
			Lantana camara L.	Sucking insect
			Datura metel L.	Insect repellent
			Murraya paniculata(L.) Jacq.	Insect repellent
			Clerodendrum viscosum Vent.	Insect repellent
			Justicia adhatoda L.	Insect repellent
Dagapur T.E	Terai	26.7430° N, 88.4043° E	*Melia azedarach* L.	Red spider mite
			Clerodendrum viscosum Vent.	Insect repellent
			Polygonum hydropiper L.	Looper Control
			Vitex negundo L.	Red spider mite
Mohurgong & Gulma T. E	Terai	26.794567°N 88.385543°E	*Clerodendrum viscosum* Vent.	Insect repellent Sucking pests
			Vitex negundo L.	Tea mosquito bug
			Polygonum hydropiper L.	Red spider mite, Looper Insect repellent
			Ageratum conyzoides L.	Red spider mite
			Melia azedarach L.	Tea mosquito bug,
			Azadirachta indica A. Juss.	Red spider mite, Black rot
			Ipomoea carnea Jacq.	Tea mosquito bug, Black rot, Red rust Insect repellent
			Pongamia pinnata (L.) Pierre.	Insect repellent
			Moringa oelifera Lam.	Insect repellent
			Dillenia indica L.	Insect repellent
New Dooars T.E	Dooars	26.844423^0N, 89.070462^0E	*Aspidium felix* mas (L.) Sw.	Tea mosquito bug Insect repellent
			Clerodendrum viscosum Vent.	Insect repellent
			Justicia adhatoda L.	Looper Control
			Polygonum hydropiper L.	Looper Control
			Vitex negundo L.	Red spider mite
			Melia azedarach L.	Red spider mite
Debpara T. E	Dooars	26.8331°N, 89.0120°E	*Clerodendrum viscosum* Vent.	Insect repellent
			Justicia adhatoda L.	Insect repellent
			Polygonum hydropiper L.	Looper Control
			Vitex negundo L.	Red spider mite
			Melia azedarach L.	Red spider mite

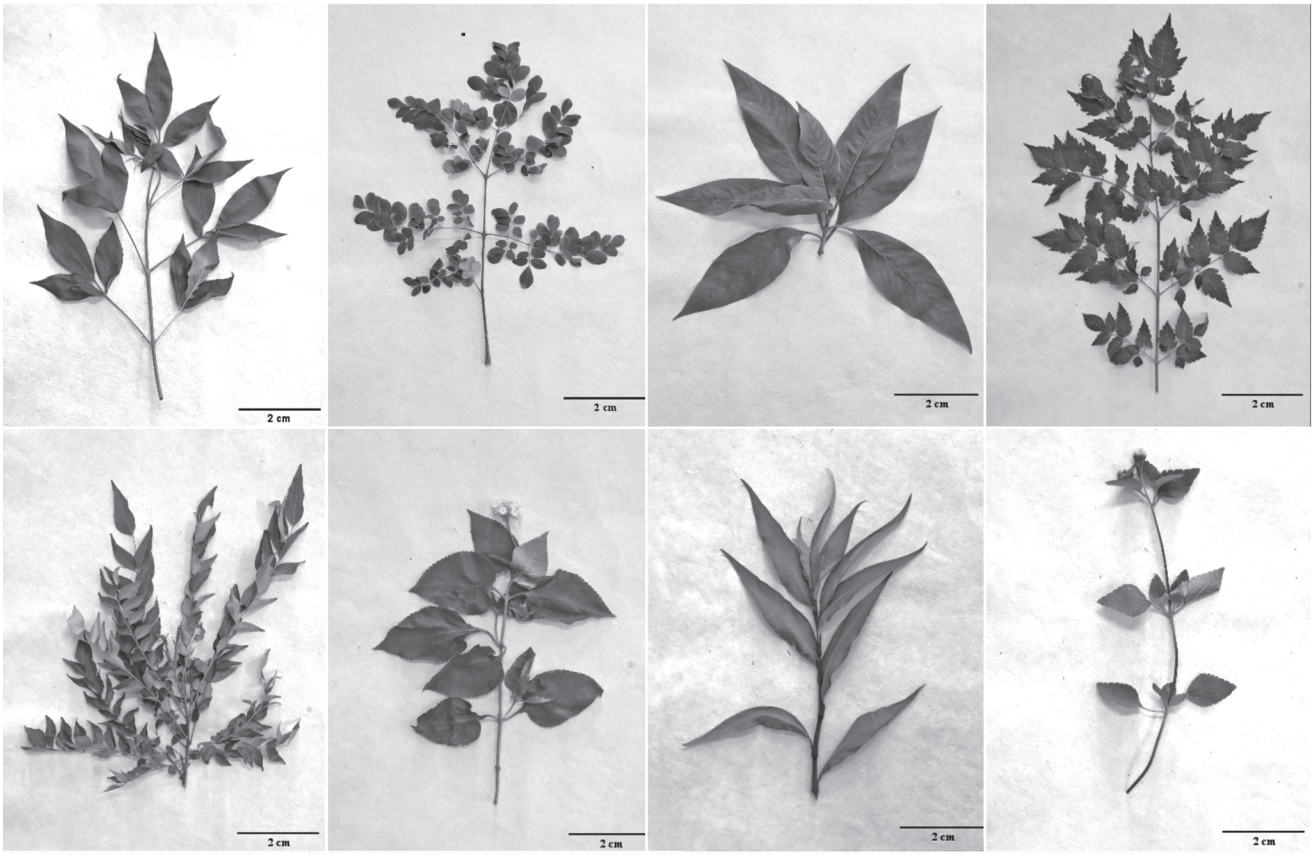

Fig. 2: Some selected plants used in bioformulation: a. *Moringa oleifera* Lam.; b. *Justicia adhatoda* L.; c. *Vitex negundo* L.; d. *Melia azedarach* L.; e. *Murraya koenigii* L. Spreng; f. *Lantana camara* L.; g. *Ageratum conyzoides* L.; h. *Polygonum hydropiper* L.

fencing plant in tea gardens. The above-mentioned plants are also used in home remedies for common ailments among workers like cough & cold.

The pest management adopted by various tea growers included in our survey area varies from one another according to their traditions and climatic variations and subsequent floristic diversity. The explanations of the effectiveness of the botanicals against tea pests by the tea planters differ and some claim that the botanicals themselves aren't responsible for the immediate death of the pests such as the red spider mite, loopers, etc, but the antifeedant, repellent activity of the botanicals led to the loss of feeding and eventual death of these pests[12]. The botanicals which had collected from local areas adjoining the tea garden of Dooars and Terai region were identified in the Department of Botany, University of North Bengal. Further, some of them claim that these botanicals improve the immunity of the bushes rendering them resistant to pest attack. They have shown readiness in adopting these alternative means of controlling the pest even though they differ in their opinion of the mode of action of these formulations.

Indigenous Technical Knowledge (ITK) may serve as a foundation for scientists to implement integrated pest management as it is the outcome of centuries of trial and error, natural selection, and acute observation. The negative impacts of synthetic pesticides on crop and health has initiated a renewed interest in botanicals and a trend to avoid the chemicals as much as possible. The necessity of protecting Indigenous Technical Knowledge is inevitable in the present scenario. The best way to accomplish it is through documentation of this traditional knowledge. Documentation of this information which is on the verge of being lost with time will work as a knowledge base for future researchers and planters and help to develop new tactics in preparing planters for unpredictable situations.

Conclusion

The present work envisages collecting and documenting the pest-repellent plants against tea pests used in the formulations of tea gardens of North Bengal. The identification of the common plants of bioformulation may bring a combined effort to develop a target-specific

biopesticide for mitigating and controlling tea pests. Documenting, studying, and most importantly sharing such knowledge will work as the foundation for local-level decision-making in agriculture, medicine, food preparation, education, and management of natural resources, and help to improve the overall economy. To the best of our knowledge, this survey is a pioneering effort to collect information about the plants of the bioformulation employed in the tea gardens of this region.

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