Research Article

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Observations on the herbivore diversity in a managed tea plantation and population dynamics of major insect pest in tea with regional weather

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Abstract

Globally, the pattern of incidence of insect pest complex has been changing in all agroecosystem due to climate change and variability. It is essential to know the incidence pattern of insect pest complex in tea for adopting successful management practice. An investigation was carried out to know the present incidence pest scenario of tea at Assam during March 2019 to Feb 2020. The results show the presence of four mite species belonging to single order and 4 families, and a total of 33 insect species belonging to 7 orders and 27 families. Among them red spider mite, tea mosquito bug, whitefly, leafhopper complex and thrips were recorded as important sucking pests. Leaf roller, tea tortrix, and flush worm were recorded as significant chewing pests. Observation shows that the tea whitefly, leaf hopper, thrips, leaf roller and flush worm has become a serious threat to the tea cultivation. The population dynamics of red spider mite and tea mosquito bug recorded a maximum incidence of 30.27 mites/ leaf and 27.17 infested flush/ bush respectively, during the month of November. Both insects were negatively regulated by maximum temperature and rainfall however relative humidity positively influenced population dynamics, as revealed by the correlation coefficient. This study paves way for the development of a new plant protection module to manage the emerging insect pests in tea plantation.

Keywords: Tea pest incidence, red spider mite, tea mosquito bug, leafhoppers, whitefly

Introduction

Tea, *Camellia sinensis* (L.) O. Kuntze, is a perennial crop grown in extensive monoculture in diverse agro ecological conditions experiencing a wide range of climatic conditions in tropical environment. In India tea is cultivated in 15 states, of which Assam, West Bengal, Tamil Nadu, Kerala are the major states accounting for nearly 98 % of the total production. Crop loss in tea due to pest damage may be from 10% to 40% (Banerjee, 1981). Globally about 1031 arthropod species are associated with tea bushes (Chen and Chen, 1989). Among them about 3% of the pests are common throughout the world. The magnitude of pest infestation varies depending on altitude, climate and cultural practices. However, each geographic region may have its own distinctive pest complex. Insect are cold blooded hence changes in temperature greatly affect the life cycle of the insects (gilbert and rowarth, 1996). It is reported that unfavorable weather conditions in terms of decreasing rainfall and increasing temperature have adversely affected the tea plantations in various parts of Assam and North Bengal (Roy *et al*., 2020). During 1950s the incidence of mites on tea bushes was minimal with low multiplication rate (Das, 1957). , In the succeeding decades, decrease in rainfall and increase in temperature enhanced the population density of red spider mite even during the winter months in the tea plantations of north-eastern India (Roy *et al*., 2014). Interestingly, half a

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century ago, higher incidence of tea mosquito bug was reported only during May to July, when the number of rainy days was more, rainfall was steady and cloudy weather conditions prevailed but presently the bug is reported to be more frequent during late monsoon and autumn months (Mukhopadhyay and Roy 2009). Climate change induced shift in rainfall has increased the incidence of tea mosquito bug in the late monsoons and autumn in the northeast India (Roy *et al*., 2015). Minor and occasional pests like tea thrips (*Scirtothrips dorsalis*) and green leaf hoppers (*Empoasca flavescens*) occurring in localized areas of the tea plantations are turning into a serious and regular pests in tea plantations of northeastern India (Roy *et al*., 2009; Saha *et al*., 2012). Dubey (2018) reported a new whitefly genus and species, *Aleuroparvus theae* Dubey (Hemiptera: Aleyrodidae) colonising Assam tea (*Camellia sinensis*) and *Cinnamomum bejolghota*, in North-East India. The pest scenario on tea is changing drastically, and undoubtedly climate change is playing a crucial role (Kumar *et al.,* 2008). Based on these observations, the present study was attempted to understand-the incidence pattern of insect pest complex in tea plantations in Assam in order to develop a better management practice.

Materials and methods

The study on the periodical incidence of arthropod pest complex on the tea crop was carried out through fixed plot survey in total experimental area of a thousand square meter of an established tea garden from March 2019 to February 2020. The experimental site is situated at Assam Agricultural University, Jorhat with 94º 13″ E longitude and 26º 45″ N latitude and altitude of 86.56 meters from the mean sea level.

In situ and knock down methods were used to record the incidence pattern of tea pest complex at weekly interval. In the former – a visual observation on occurrences of all the incidence insects and population indices of tea mosquito bug on tea canopy were recorded from 50 randomly selected tea plants. The knock down method was used to record the incidence of mites. Five plants were randomly selected, three leaves per plant were plucked and these samples were placed in separate polythene bags with proper label, and brought to the laboratory for identification. Only the red spider mites and tea mosquito bug population dynamics were recorded throughout study period following appropriate methodology (Roy *et al*., 2014) and (Roy *et at*., 2008), respectively. The data was analyzed in R software using packages agriclolae and corrplot. No plant protection measures were carried out in the experimental site during the study period.

During the experimental period all data on meteorological factors viz., temperature (maximum and minimum), relative humidity (morning and evening), total rainfall and bright sunshine hours were obtained from the Department of Agrometeorology, Assam Agricultural University (AAU), Jorhat, Assam.

Results and discussion

Seasonal Incidence of different pests

Temporal patterns in the abundance and species composition of arthropod pest complexes in tea recorded at weekly intervals from March 2019 – Feb 2020 by fixed plot survey are presented in Table 1. The results have shown the presence of four mite species belonging to single order and 4 families, and a total of 31 insect species belonging to 7 orders and 27 families. Among them red spider mite, tea mosquito bug, whitefly, leafhopper complex and thrips were recorded as important sucking pests in the order indicated. The leaf roller, tea tortrix, and flush worm were recorded as significant chewing pests in the order mentioned (Table. 1). Considering the number of occurrence months the tea whitefly, leaf hopper, thrips, leaf roller and flush worm have become a serious threat to the tea cultivation. Ahmed and Mamun, (2012) found that the incidences of major pest complex in tea in Bangladesh comprised of red spider mites (31.29%), Helopeltis (17.45%) and termites (13.15%) followed by jassids, flush worms and aphids. Among the non- insect pests four mites species viz, red spider mite, scarlet mite, pink mite and yellow mite occurrences were recorded in different periods. Red spider mites incidence was

Table 1. Seasonal Incidence of different pests in tea throughout the year March 2019 - Feb 2020

S. No	Pest	Scientific name	Order- Family	Month of occurrence
		Non insect pest		
1	Red spider mite	*Oligonychus coffeae*	Acarina, Tetranychidae	Around the year
2	Scarlet mite	*Brevipalpus phoenicis*	Acarina, Tenuipalpidae	November
3	Pink mite	*Acaphylla theae*	Acarina, Eriophyidae	Nov- Dec- Jan- Feb- Mar- April
4	yellow mite	*Polypgagotarsonemus latus*	Acarina, Tarsonemidae	Nov- Dec- Jan- Feb- Mar- April
		Sucking - Insect pest		
5	Tea mosquito Bug	*Helopeltis theivora*	Hemiptera, Miridae	Throughout the year
6	Aphid	*Toxoptera aurantii*	Hemiptera, Aphididae	July- Aug- Sep- Oct Dec- Jan- Feb
7	Assam tea Thrips	*Scirtothrips dorsalis*	Thysanoptera, Thripidae	Oct- Nov- Dec- Jan- March- April- May
8	Leaf thrips	*Mycterothrips setiventris*	Thysanoptera, Thripidae	Oct- Nov- Dec- Jan-March- April
9	Scale insects	*Pinnaspis sp.*	Hemiptera, Diaspididae	Aug- Sep- Oct- Jan- Feb- Mar
10	Hemispherical Scale	*Saissetia coffeae*	Hemiptera, Coccidae	Sep- Oct
11	Green scale	*Coccus viridis*	Hemiptera, Coccidae	March
12	Stem scale	*Fiorinia theae*	Hemiptera, Diaspididae	Nov- Dec
13	Tea seed bug	*Poecilocoris latus*	Hemiptera, Pentatomidae	Nov- Dec- Jan
14	Tea leaf miner	*Agromyza theae*	Diptera, Agromyzidae	Oct- Nov
15	Leaf hopper	*Empoasca flavescens*	Hemiptera, Cicadellidae	Nov- Dec- Jan- Feb- March- April
16	Leaf hopper	*Hishimonus phycitis*	Hemiptera, Cicadellidae	Feb- March
17	white fly	*Aleurocanthus camelliae*	Hemiptera, Aleyrodidae	Aug- Sep- Oct
		Insect Pest-Defoliators		
18	Flush worm	*Laspeyresia leucostoma*	Eucosmidae, Lepidoptera	Oct- Nov- Dec- March- April
19	Tea leaf-roller	*Gracilaria theivora*	Gracilariidae, Lepidoptera	Oct- Nov- Dec- March- April
20	Tea tortrix	*Homana coffearia*	Tortricidae, Lepidoptera	Oct- Nov- Dec- March- April
21	Tea leaf weber	*Striglina glareola*	Thyrididae, Lepidoptera	Nov- Dec
22	Bunch caterpillar	*Andraca bipunctata*	Bombycidae, Lepidoptera	Dec- Jan
23	Small faggot worm	*Clania destructor*	Psychidae, Lepidoptera	Jan
24	Sanwich caterpillar	*Agriophora rhombata*	Tineidae, lepidoptera	Sep
25	Nettle Grub	*Parasa pastoralis*	Limacodidae, Lepidoptera	Oct
26	Gelatine Grub	*Cheromettia apicata*	Limacodidae, Lepidoptera	Dec- Jan- Feb
27	Common Looper	*Biston suppressaria*	Geometridae, Lepidoptera	July- Aug
28	Looper caterpillar	*Hyposidra talaca*	Geometridae, Lepidoptera	Aug- Sep- Oct
29	Hairy Caterpillar	*Somena scintillans*	Lymantriinae, Lepidoptera	July- Aug
30	Hairy caterpillar	*Euproctis fraternal*	Lymantriinae, Lepidoptera	Dec- Jan- Feb
31	Black hairy caterpillar	*Olepa ricini*	Erebidae, Lepidoptera	Dec- Jan
32	Tobacco grasshopper	*Atractomorpha crenulata*	Pyrgomorphidae, Orthoptera	Nov- Dec
33	Rice grass hopper	*Hieroglyphus banian*	Acrididae, Orthoptera	July- Nov- Dec
34	Lobster caterpillar	*Stauropus alternus*	Notodontidae, Lepidoptera	July- Aug
		Other Insect pest-Termites		
35	Livewood eating termites	*Microcerotermes* spp.	Termitidae, Isoptera	

found throughout the year, scarlet mite was incidence was found only in November, Pink mite incidence was found in the period between November to March and yellow mite incidence was found between November to April. These findings were supported by Cranham (1966) who recorded mites, as a group, are persistent and the most serious pests of tea in almost all tea producing countries. Devi *et al*., (2016), reported that red spider mite, (*Oligonychus coffeae*), leaf roller, (*Caloptilia theivora*), thrips (*Mycterothrips setiventris*) and aphid, (*Toxoptera aurantii*) are major pests and the rest as minor pests.

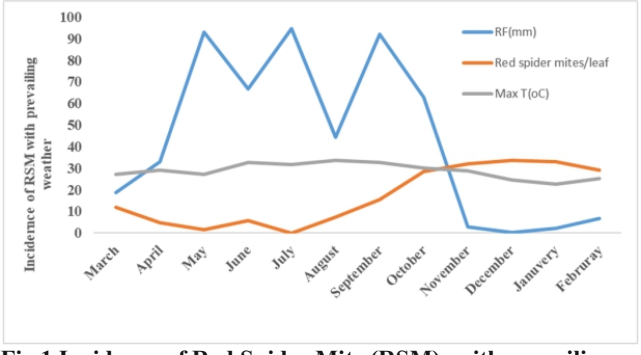

Fig.1 Incidence of Red Spider Mite (RSM)- with prevailing weather Rainfall (RF)- Maximum Temperature (MaxT).

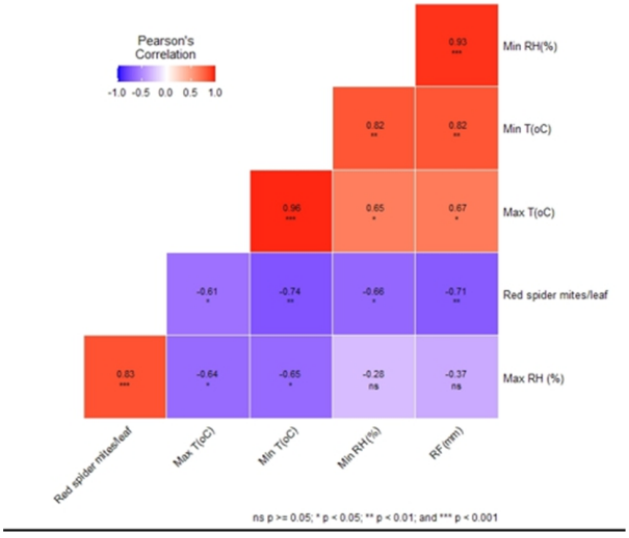

Fig. 2 Correlation cofffecient between between the incidence of red spider mite (RSM) and abiotic factors.

Field assessment on the incidence of red spider mite population density show that the maximum population (30.17 mites/ leaf) in the month of November. From March the RSM population started increasing with the increasing temperature- however frequent and monsson precipitation caused reduction of mites from leaf surface and once the monsoon retreated the RSM population increasing from October (Fig .1). Surprisingly the correlation coefficient between RSM incidence and abiotic factors shows significantly Negative correlation with all the weather parameter except Maximum relative humidity which shows a significantly positive correlation coefficient ($\mathbf{r}_{max.temp}$ = -0.61; $r_{min.tem}$ = -0.74; $r_{max.\ RH}$ = 0.83; $r_{min.\ RH}$ = -0.66; $r_{Rainfall}$ = - 0.71). This finding was supported by (Roy *et al*.- 2014) that the RMS infestation starts from late March and early April and the monsoon rains washed off the active forms from the leaves. And also the increased temperature enhances the mite population during winter months (Roy *et al*.- 2020). However Kachhawa and Rahman- (2015) found that maximum and minimum temperature showed positive correlation with RSM incidence and significantly negative correlation with relative humidity and rainfall.

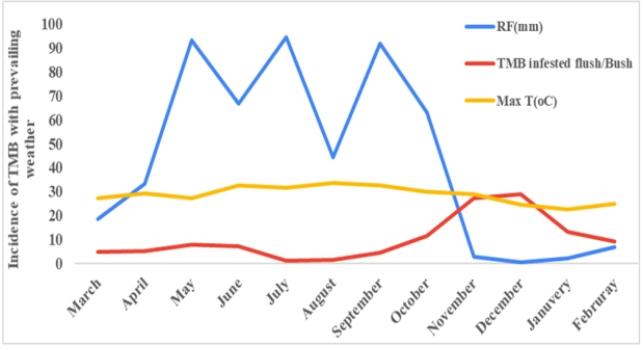

Fig.3 Incidence of Tea Mosquito Bug (TMB)- with prevailing weather Rainfall(RF)- Maximum Temperature(MaxT).

Field assessment on the incidence of Tea musquito bug infestation shown that the maximum infestation (27.17 infested flush/bush) in the month of November. From March the Tea musquito bug population and infestation start increasing with increasing temperature- however frequent and monsoonal precipitation leads to declined infestation rate and once the monsoon retreated the Tea musquito bug infestation increased from October (Fig .4) Surprisingly the correlation coefficient between tea mosquito bug infestation

and abiotic factors shows significantly negative correlation with all the weather parameters except maximum relative humidity which shows significantly positive correlation ($\mathbf{r}_{max.temp}$ = -0.52; $r_{min.tem}$ = -0.41; $r_{max.\ RH}$ = 0.67; $r_{min.\ RH}$ = -0.66; $r_{\ Rainfall}$ = -0.61). Kalloor *et al*.- (2022) reported that Maximum temperature and Rainfall negatively influence the tea mosquito bug infestation in neem. Roy *et al*.- (2008) found that relative humidity show positively regulation and Rainfall shows negative impact on the tea mosquito bug population. Roy *et al*-)2020) reported that- In north-eastern India- changes in the weather pattern has been witnessed as a decrease of around 200 mm rainfall over the years- increase in average temperature of around 1.3 °C over the last 93 years causing changes in insects pest incidence and infestation severity in tea plantation. In addition emergence of minor pest as a major pest is a huge challenge in tea cultivation

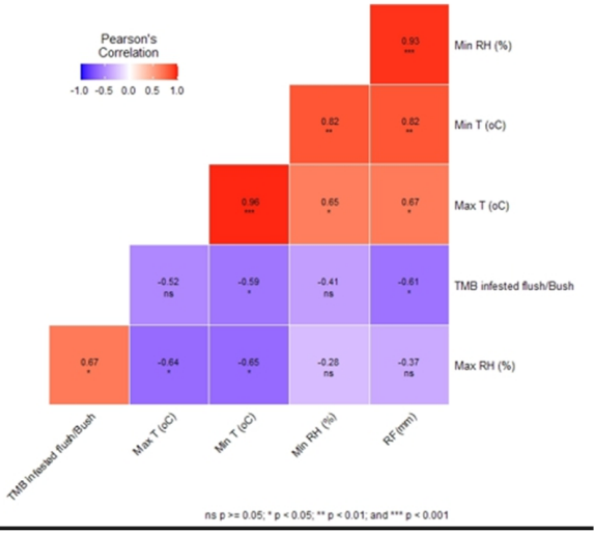

Fig. 4 Correlation coffecient between incidence of Tea musquito bug and abiotic factors.

Months of infestation reveal that in addition to red spider mite and tea mosquito bug- many minor pests such as leaf roller- flush worm- leafhopper complex- white fly and thrips- are emerging as major insect pest of tea plantation. Therefore attention is needed to control the changes in insect pest incidence status with prevailing regional weather pattern and emerging insect pest complex in tea plantation. Hence- it is essential to develop new plant protection measures based on insect incidence pattern and climate variability in region wise.

Conclusion

Findings reveal that- incidence pattern of pest scenario of tea has changed in the present climate change scenario. So it is essential to develop new plant protection strategies for successful management of emerging insect pest in tea plantation. Most importantly developing weather based simulation and insect pest prediction model for pest incidence on all tea growing regions of India and need based application of insecticides would be ecologically sound and cost effective management of insect pest in tea.

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