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Control of Red spider mite (*Oligonychus coffeae*, Nietner) in tea [*Camellia sinensis* L. (O) Kuntze] plantation of Barak Valley (Southern Assam) using Allelopathic plant extracts

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ABSTRACT: The red spider mite is the most widely distributed and probably the most serious pest of tea in north-eastern India. It also occurs on tea in other parts of India and also in other tea growing countries. Red spider mite normally attacks the upper surface of the mature leaves in which the sap is not flowing freely. In a severe infestation, particularly under conditions of dry weather, the lower surface and the young leaves are almost equally attacked. The affected leaves turn ruddy bronze, and may eventually dry up and fall off. In the present study, varied severity of damage caused by Red spider mite (*Oligonychus coffeae*, Nietner) was observed in three different seasons i.e. winter, summer and rainy season in the tea growing sub areas of Barak Valley, South Assam. The pest population was found to be seasonally variable and dependent on the prevailing agro-climatic conditions (viz. ambient temperature, rainfall and relative humidity). In the present work allelopathic plant extracts were used to control this pest i.e. Red Spider mite. Among the allelopathic plant extracts used in the experiments for controlling the population of red spider mite in tea *Parthenium hysterophorus* controlled the pest reasonably well followed by *Clerodendrum viscosum*, *Chromolaena odorata* and *Ipomea carnea*, respectively.

KEYWORDS: *Allelopathy;* Chromolaena odorata; Clerodendrum viscosum; Ipomea carnea; *Red Spider mite* (Oligonychus coffeae); Parthenium hysterophorus

Introduction

The red spider mite, *Oligonychus coffeae* (Nietner) has been known as an important pest of more than a hundred crops, including mango, coffee, tea, cotton and jute in tropical and subtropical regions.[1-3] Seasonal occurrences of *O. coffeae* on tea plants are reported from India,[4,5] Taiwan[6] and Sri Lanka.[7] The influence of temperature on the development of *O. coffeae* was investigated for the tea populations of India.[8] This species is the most serious pest in the tea-growing areas of tropical and subtropical regions. Red spider normally attacks the upper surface of the mature tea leaves in which the sap is not flowing freely. In a severe infestation, particularly under conditions of dry weather, the lower surface and the young leaves are almost equally attacked. The affected leaves turn brown, then bronze, and may eventually dry up and fall off.[9,10]

The red spider mites live under a cover of web that they spin as a protection against inclement weather. The pest occurs in severe form from March to June, but with the monsoon rains it practically disappears. A second, light, attack may, however, develop in September or October. Among all the pests occurring in tea fields of Barak valley, red spider mites (*Oligonychus coffeae*, Nietner) has been found to occur as one of the major damages causing pest occurring throughout the year. So far, except the work of Choudhury *et al.*[22] comparatively very little work was done on the various aspects of the pest under the agro-climatic condition of Barak valley, Assam. Red spider mite, *Oligonychus coffeae* (Nietner), had been causing a considerable damage since 1960, but recently it is found to be more prominent at Terai, Dooars and Assam regions. Different classes of acaricides (i.e. Dicofol, ethion, sulfur, propargite, fenazaquin) are being used by the tea planters to combat the menace from red spider mite.

The latest surveillance report of the European Community (EC) in 2004 indicating the presence of pesticide residues in Assam tea is a cause of great concern. Authorization of 450 compounds have already been withdrawn by EC for use on agriculture products have adversely affected the tea exports of many countries including India since it withdraws the approval for ethion, which is extensively used for mite control in tea. Recently it has been reported that the incidence of ethion residue in Indian tea was higher than the prescribed maximum residue limit (MRL) to the tune of 14.2%, 32.9% and 17.8% in the year 2002, 2003 and 2004.[11,12] Assam tea continues to record high number of positive values for organo-

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chlorine pesticide residues, very few of which exceeded the EU maximum residue level. Thus, incidence of DDT (13.8 and 47.1% in 2002 and 2004, respectively) and dicofol (70.4 and 82.4% in 2002 and 2004, respectively) remain comparatively high.[11, 12] The incidence of DDT in Assam teas is increasing and few samples contained more than the 0.2 mg kg^{-1} limit. Further, it is pointed out that impurity in dicofol, which contains DDT as contaminant might cause the adverse effect. It may be mentioned that DDT is a banned substance for application in tea in India and many parts of the world. Currently, the Central Insecticide Board (CIB) and Prevention of Food Adulteration (PFA) regulation committee have reviewed the Maximum Residue Limit (MRL) position for tea and have recommended the use of only 16 insecticides and acaricides, 8 herbicides and 8 fungicides for use in tea.[13]

To overcome the current crisis being faced by the tea industry, there is need to switch over to alternatives such as the use of biorational products (i.e. plant extract having insecticide properties, microbials, etc.), which are abundant in source and not being tapped properly. From the academic point of view, plants represent a vast storehouse of potentially useful natural products, and indeed, many laboratories worldwide have screened thousands of species of higher plants not only in search of pharmaceuticals, but also for pest control products.[14-18] Allelopathy concerns the effect of one plant on another due to chemicals released by them, or the breakdown products of their metabolites.[19] Allelopathy has been suggested as a mechanism for the impressive success of invasive plants by establishing virtual monoculture and may contribute to the ability of particular exotic species to become dominant in invaded plant communities.[20, 21] Hence in this study an attempt was made to explore the potential and utilization of commonly available allelopathic plants (i.e. *Parthenium hysterophorus*, *Chromolaena odorata*, *Clerodendrum viscosum* and *Ipomea carnea*) to control the population of red spider mites under the agro-climatic condition of Barak valley, Assam.

Materials and Methods

An initial survey was carried out in the tea-growing areas of Rosekandy Tea Estate (Barak Valley, Southern Assam). Foliage which are turning brown to bronze colour in the areas showing various degrees of Red spider mite (*Oligonychus coffeae*, Nietner) infestation was selected as the experimental site. The experiment was laid out in randomized block design with five sets of replications. Sample blocks were prepared comprising 25 bushes each, in each set of the treatment.

For sampling 25 bushes for each treatment, 25 × 5 = 125 numbers of bushes were selected including the control. Before and after spraying the experimental allelopathic plants extracts, the number of mites present in the infested foliage, was recorded from the five leaves, of the infested bushes (one each from the centre, east, west, north and south direction) were plucked. These five leaves plucked were put inside a plastic bag. The collected leaf specimens were brought to the laboratory and a piece of cotton wool soaked in ethyl alcohol was placed inside the plastic bag to make the pests immobile on the dry surface for the counting.[22]

Preparation of the Plants Extract

The plant extracts were prepared following the modified method as described by Ghosh Hazra *et al.*, 1994. The fresh leaf of *Parthenium hysterophorus*, *Chromolaena odorata*, *Clerodendrum viscosum* and *Ipomea carnea* were collected. From 300 g of green leaves, about 200 ml of juice was extracted. The green leaves were grinded with the help of a grinder mixture to extract its juice and the same was then filtered. The filtrate was then diluted in water at the ratio of 1:5 for spraying in the tea bushes.

All the above-mentioned plant extracts were applied separately as foliar spray with a hand sprayer. Untreated (control) plots were sprayed with the same amount of water, for comparison. Spraying was done five times at an interval of one week, and the data was collected for six times including once before spraying. The efficacy of the treatments, i.e. reduction in mite population was evaluated by counting the average number of individual mite per leaf in 25 bushes taken at random from each sample block. The data were subjected to analysis of variance (ANOVA) to find out test of significance (*F* value) and critical difference (CD at 5% and 1%) were calculated.

Table 1: Allelopathic plants used in the experiment

Scientific name	Family	Part Used	Common Name
Parthenium hysterophorus	*Asteraceae*	Leaf	Congress grass
Chromolaena odorata	*Asteraceae*	Leaf	Siam weed
Clerodendrum viscosum	*Lamiaceae*	Leaf	Glory tree
Ipomea carnea	*Convolvulaceae*	Leaf	Dhol-Kolmi

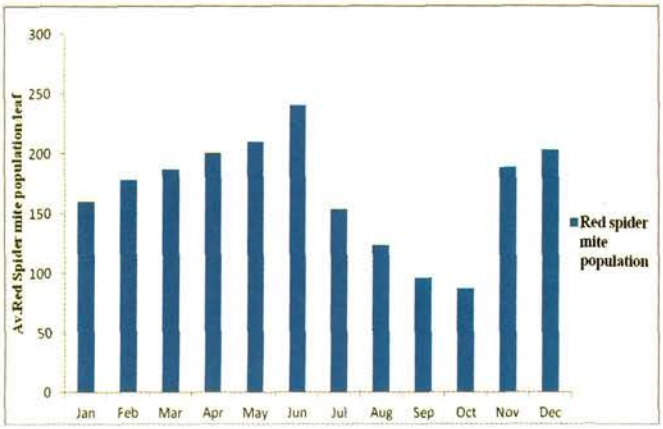

Fig. 1: Seasonal variation in the population of red spider mites (*Oligonychus coffeae*).

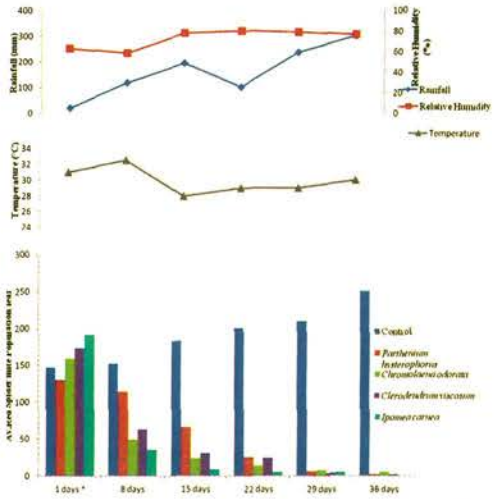

Fig. 2: Graph showing the population of red spider mite during pre- and post-treatment with the allelopathic plant extracts (foliar spray) in relation to environmental factor during summer season.

Results and Discussion

In all the bushes of the selected sites the damage caused by the pest was almost uniform with little variation. The damage was found to be highest during summer compared to two other seasons, i.e. winter and rains (Fig. 1).

During the summer season with the increase in temperature, increase in the average population of the mite also increase considerably. It is observed that the application of plant extracts *Clerodendrum viscosum*, controlled the average population of Red Spider mite almost completely, followed by *Parthenium hysterophorus*, *Ipomea carnea* and *Chromolaena odorata*, i.e. 2.4, 2.6, 3.2 and 5.5, respectively, whereas in control it is found to be 250.65 (Table 2 and Fig. 2).

During the winter season, *Parthenium hysterophorus* completely controlled the population of red spider mites followed by *Ipomea carnea*, *Clerodendrum viscosum* and *Chromolaena odorata*, i.e. number of mites, 0.52, 6.24 and 11.4, respectively, whereas in control the average population was found to be 202.83 per bush (Table 3 and Fig. 3), and it is also found that due to the environmental factors, i.e. temperature, rainfall and relative humidity, the population of mites fluctuate considerably.

During the rainy season, *Clerodendrum viscosum* controlled the higher average population of red spider mites as compared to the other allelopathic plants, i.e. *Parthenium hysterophorus*, *Chromolaena odorata* and *Ipomea carnea* 3.4, 4.6, 6.0 and 8.6 compared to the control 96.4, respectively (Table 4 and Fig. 4).

Table 2: Population decline of red spider mites (*Oligonychus coffeae*) after the foliar spraying with the allelopathic plant extracts during the summer season

Treatment/ No. of Observation	Pre-treatment (Population of Red Spider mite)	Post-treatment (Population of Red Spider mite)				
		1st	2nd	3rd	4th	5th
Control	146.4	151.6	142.6	200.8	210.2	250.65
Parthenium hysterophorus	130	113.6	65.4	25.8	6.4	1.6
Chromolaena odorata	159	48.6	23.4	13.6	7.2	5.5
Clerodendrum viscosum	173.6	63.2	30.8	24.4	4.4	2.4
Ipomea carnea	191.8	35	8.6	5.2	4.8	3.2
F value (for treatment)	3.24*	25.96*	22.03*	37.10*	87.41*	169.27*
C.D. at 5%	877.65	5055.6	679.0	10251.8	17443.8	31129.0
C.D. at 1%	2118.8	12205.4	16389.4	24750.2	42113.0	75152.7

*Significant, $P< 0.05$

Table 3: Population decline of red spider mites (*Oligonychus coffeae*) after the foliar spraying with the allelopathic plant extracts during the winter season

Treatment/ No. of Observation	Pre-treatment (Population of Red Spider mite)	Post-treatment (Population of Red Spider mite)				
		1st	2nd	3rd	4th	5th
Control	72.12	174.96	180.16	188.44	167.36	202.83
Parthenium hysterophorus	80.24	44.32	29.44	16.64	1.96	00
Chromolaena odorata	84.08	41.08	37.56	28.64	16.12	11.4
Clerodendrum viscosum	95.66	31.88	22.64	12.88	10.16	6.24
Ipomea carnea	111.76	41.08	21.08	15.88	3.24	0.52
F value (for treatment)	.951*	28.22*	40.31*	60.774*	27.43*	85.74*
C.D. at 5%	213.82	6714.30	8871.8	12123.6	7658.8	16704.4
C.D. at 1%	519.91	16209.7	21418.4	29269.0	18490.0	40327.9

*Significant, $P< 0.05$

From the present work, it has been recorded that the red spider mite is the major pest of the tea-growing areas (i.e. Barak valley) causing damage to the green tissues of leaves, thereby reducing the photosynthetic efficiency of the affected plants, resulting in yield reduction.[22] The population of red spider mites was recorded throughout the year. However, higher population was observed during the summer months followed by the winter and rainy season. It is also observed that the allelopathic plant extract application, i.e. *Parthenium hysterophorus*, *Clerodendrum viscosum*, *Chromolaena odorata* and *Ipomea carnea* controlled the population of red spider mite. Among the allelopathic plants, *Parthenium hysterophorus* shows the complete control of Red Spider mite population, followed by *Clerodendrum viscosum*, *Chromolaena odorata* and *Ipomea carnea*, respectively. Choudhury *et al.*[22] also reported that the population of red spider mites was higher in May, June and slightly reduced during the winter and monsoon seasons and can be controlled by using inorganic (i.e. Ethion, Sulfex, etc) and organic pesticides (i.e. Neemox, Bioneem and Achook).

Red spider mite population was significantly correlated in the temperature and rainfall. This aspect of mites behaviour could also be explained in the light of SEM studies on the morphology of the pest as reported earlier,[24] where it was observed that the presence of pits and some pore-less sensilla with inflexible sockets located on the upper body surface of red spider mites are related to thermo-reception. The functional significance of these sensilla is confirmed by the predominance of the insect on the dorsal surface of the tea leaves when the ambient temperature is high, causing major damage during the summer months. In the present study, almost all the allelopathic plant extract foliar spray were found to give

Table 4: Population decline of red spider mites (*Oligonychus coffeae*) after the foliar spraying with the allelopathic plant extracts during the winter season

Treatment/ No. of Observation	Pre-treatment (Population of Red Spider mite)	Post-treatment (Population of Red Spider mite)				
		1st	2nd	3rd	4th	5th
Control	87.2	123.6	153.8	173.6	148	96.4
Parthenium hysterophorus	83.8	26.2	15	10.4	9.2	4.6
Chromolaena odorata	144	42	18.2	11.4	9.4	6
Clerodendrum viscosum	118.2	30.4	21.8	19.6	12.6	6.4
Ipomea carnea	114.4	39.2	22.4	15	9.2	8.4
F value (for treatment)	5.44*	15.78*	217.07*	158.42*	29.80*	26.174*
C.D. at 5%	1177.28	3236.88	18094.33	18294.66	6864.65	5083.82
C.D. at 1%	2842.21	7814.52	43683.55	44167.19	16572.71	12273.42

*Significant, $P< 0.05$

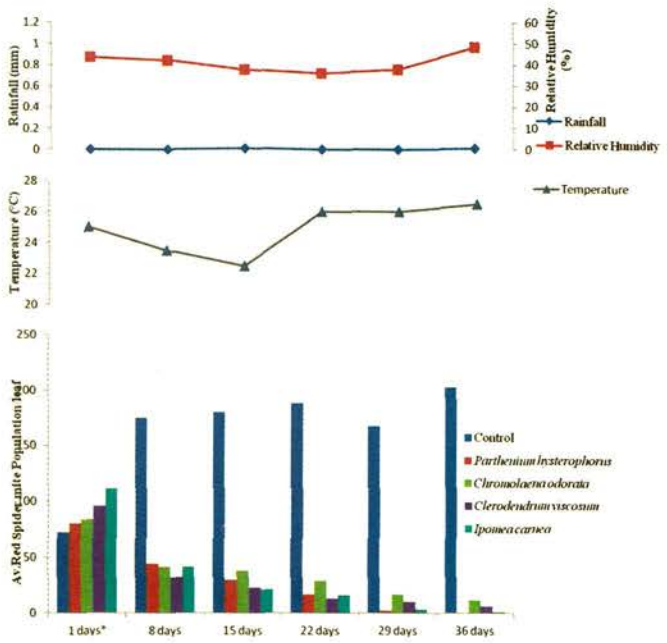

Fig. 3: Graph showing the population of red spider mite during pre- and post-treatment with the allelopathic plant extracts (foliar spray) in relation to environmental factor during winter season.

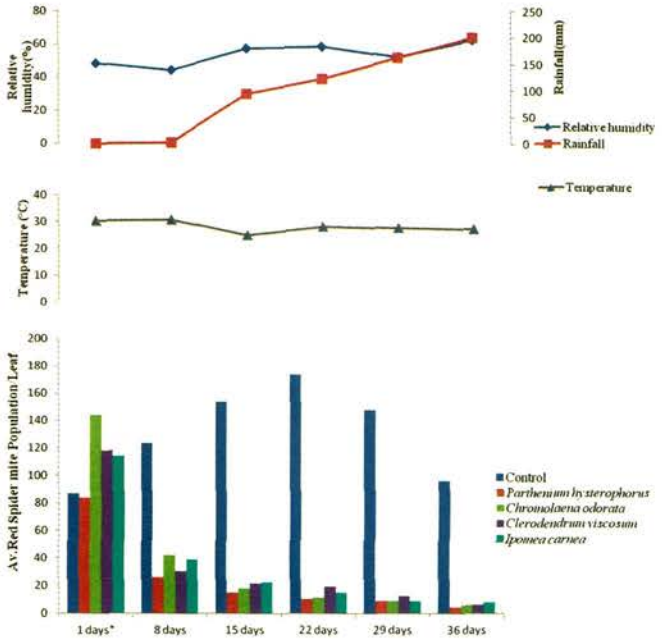

Fig. 4: Graph showing the population of red spider mite during pre- and post-treatment with the allelopathic plant extracts (foliar spray) in relation to environmental factor during rainy season.

good performance in bringing down the population of the red spider mites under control and this can help to reduce the use of pesticides for the control of Red Spider mites.

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