<u>**Original Research Report**</u>

SOME ECOLOGICAL FACTORS ON POPULATION DYNAMICS OF RED SPIDER MITE (*OLIGONYCHUS COFFEAE*, NIETNER) AND THEIR CONTROL IN THE TEA AGRO-ECOSYSTEM OF BARAK VALLEY, ASSAM (INDIA)

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ABSTRACT

Mites are serious pests of tea known since the early days in all the tea growing areas/countries. They damage the green tissues and affect photosynthesis, causing reduction in yield. In the present study, varied severity of damage caused by Red Spider Mite (Oligonychus coffeae, Nietner) was observed in different 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. temperature, rainfall etc.). Some of the clonal tea varieties were highly susceptible to red spider mite, some were moderate and others were fairly resistant.

Amongst the inorganic pesticides, a mixture of Ethion & Sulfex controlled the pest reasonably well. Of the organic pesticides, the neem-based products showed good control of the pest. A mixture of a neem based product (viz. Neemox) and Ethion gave an excellent control of the mite. Prophylactic sprays with organic and inorganic chemicals during the winter months (December – February) helped to considerably reduce the carried-over population of red spider mite, and consequently reduced the degree of infestation in the subsequent years.

Key words: *bio-pesticides, environmental factors, inorganic pesticides, integrated pest management (IPM), red spider mite, seasonal variation.*

INTRODUCTION

Mites are serious pests of tea known since early days in all the tea growing countries. They cause damage to the green tissues of leaves, thereby reducing the photosynthetic efficiency of the affected plants, resulting in yield reduction (Muraleedharan, 1992). The red spider mite was discovered in Assam in 1868, and by 1880, it became widespread. From 1881, it has increased in alarming proportion and spread to almost all the districts where tea is grown (Das, 1963). The red spider mites primarily concentrate on some localized areas on the dorsal surface of leaves, wherefrom they usually start damaging and later on this damage spreads to other areas of the plant body, like midrib, veins, shallow depressions on leaves etc. (Banerjee, 1965; Muraleedharan, 1983). The red spider mites cause extensive damage to tea crop in most of the countries of south East Asia, India, Africa and Srilanka. Ma and Yuen (1976) reported severe outbreak of this species in the Fukien area of China.

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So far, comparatively very little work has been done on the severity of damage, inter-clonal variation, seasonal variation in population and control measures of, red spider mite under the tea agro-climatic conditions of Barak valley,South Assam. In the present work, an attempt has been made to study the above mentioned aspects of the pest with a view to formulate appropriate control measures for better management of the pest in general, and under the agro-climatic conditions of Barak Valley.

MATERIALS AND METHODS

Severity of infestation

The tea-growing region of Barak valley is divided into five sub-areas. These are Chatlabheel, North Cachar and Happy valley sub-areas (in Cachar dist.), Hailakandi sub-area (in Hailakandi dist.) and Longai valley & Karimganj sub-area (in Karimganj Dist.). In an attempt to assess the severity of infestation of red spider mite (*Oligonychus coffeae*, Nietner) in different tea growing sub-areas, a survey was conducted in 67 tea estates, all located in different tea growing sub-areas of Barak valley. In all these sub-areas, monthly observations were carried out for three consecutive years.

The incidence of *O. coffeae* was estimated by systematic sampling method (a modified method followed by Sarkar, 1977). Using this method, one bush was selected at random from each row of bushes, followed by selecting every fifth bush in the row. To illustrate, where the 4^{th} bush of the row was sampled, the subsequent bushes to be sampled in the row were 9^{th}, 14^{th}, 19^{th} etc. and so on. In the study, the severity of damage was graded to assess the degree of infestation, as follows;

0 = Un infested (leaves unaffected)

1 = Mild infestation (1 – 33% leaves affected)

2 = Moderate infestation (34 -66% leaves affected)

3 = Severe infestation (67 - 100% leaves affected)

Observations on the clonal susceptibility

To determine the variation in clonal susceptibility due to *O. coffeae* infestation, mite population was recorded on eighteen tea clonal varieties (i.e., TV 4, 7, 8, 9, 11, 14, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26 and 28) in Bagla experimental plot of TRA, Cachar, Assam. Sample blocks of each tea variety were selected comprising 50 bushes, of 8-9 years old age-group. Three replications of each clonal plot were taken. The percentage of infestation in different tea varieties were then calculated to determine which clone(s) was/were more susceptible /resistant to red spider mite infestation under the agro-climatic conditions of Barak Valley.

Population Survey

Seasonal variation of population: - A survey was carried out in Bagla experimental plot of TRA, Cachar, Assam to monitor the seasonal fluctuation in population. The methodology of survey was identical to that followed for assessing the severity of mite infestation.

In the second phase of the survey, five leaves each from the bushes selected by the above-mentioned method were plucked for estimating the number of mites present in the leaves. These leaves were plucked @ one each from east, west, north, south and one from the center of the bush canopy/frame. The number of mites present in the individual bushes was counted, fortnightly. The mean of

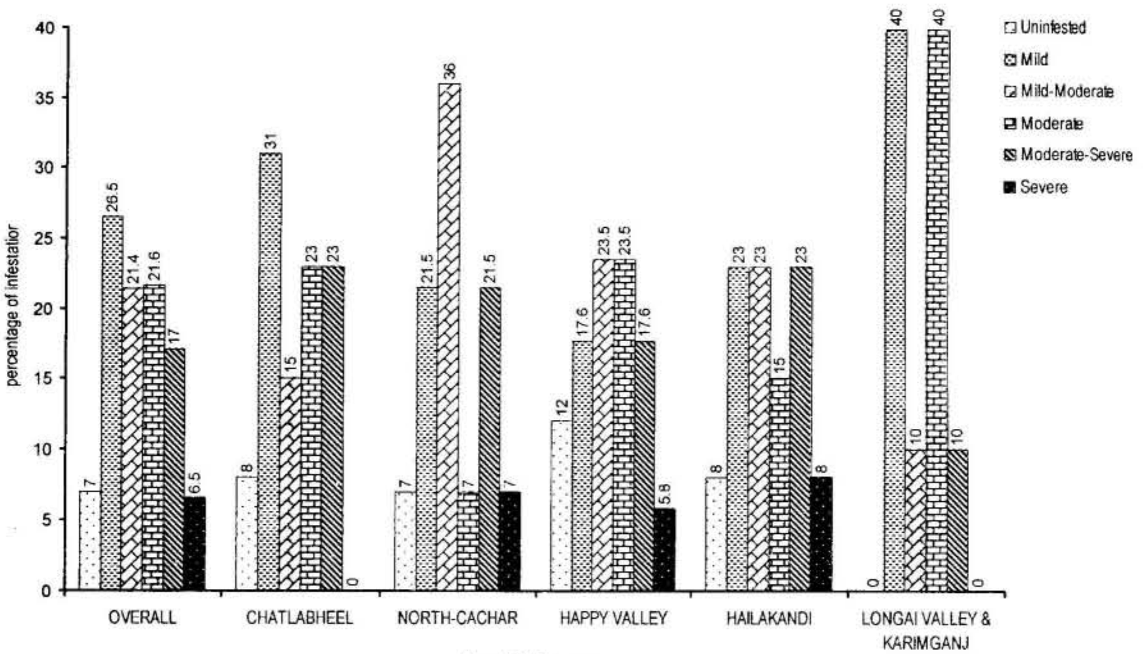

Fig. 1 Overall & Sub-areawise Variation of infestation by Red Spider Mite in tea estates of Barak Valley
(based on three years data & sampling of over 10,000 bushes in each of the 67 tea estates)

two observations taken in a month was taken as the population for that calendar month. To minimize error due to year-to-year variation in the occurrence of the pest, month wise mean population over three years was calculated to determine the pest population for a particular month.

Seasonal variation of red spider mite in relation to the environmental conditions of Barak Valley: - Correlation computations were run with seasonal variations in population of red spider mite to assess if any significant correlation exists between the pest incidence, their severity and seasonal fluctuations in relation to the prevailing environmental conditions (i.e., Maximum temperature, Minimum temperature and the Rainfall).

Control measures

Randomised plots of red spider mite infested areas of Bagla Experimental plot, TRA, Cachar (Assam) were given prophylactic treatments (two rounds of spray in one month's interval) with inorganic insecticides, *viz.* Ethion 50EC (*ai* Organophosphate) and Sulfex 80%wp (*ai* Sulphur) in dilutions of 1:200 and 1:400, respectively. Some experimental plots were treated with a mixture of Ethion + Sulfex (1:1) and Ethion + Neemox (1:1).

Some more experimental areas received neem-based bio-pesticides (*viz,* Achook, Bioneem and Neemox) in water dilution of 1:200.

The same treatments (with inorganic and bio-pesticides) were repeated for three consecutive years, (two sprays in one month interval) on the same set of plots in a randomized block design.

RESULTS

Severity of infestation

Amongst the 67 tea estates of Barak Valley in which the survey was carried out to assess the severity of damage due to red spider mite, the infestation was observed to persist almost throughout the year, (with higher incidence/ damage observed during May to September) with wide range of variations. To describe an overview, 7% of the gardens under study showed no infestation. The degree of infestation was mild in 26.5% of the tea estates. Mild to moderate infestation was found in 21.4% of the tea estates. Moderate infestation was also observed in one fifth of the tea estates (21.6%). Moderate to severe infestation was observed in 17% tea estates, while severe infestation was observed in only few tea estates (6.5%) (Fig.-1). From the figure, it is also evident that in all the tea growing Fig 1 sub-areas, the degree of infestation caused by the pest did not menifest a wide range of variation. However, the degree of infestation in general was observed to be highly variable from season to season and from year to year.

Clonal susceptibility

Eighteen tea varieties were observed for one year to assess the variation in clonal susceptibility to red spider mite infestation. The highly susceptible clones were TV19 and TV20, While TV7, TV22, TV23 and TV24 were comparatively less susceptible. TV11 and TV26 were moderately susceptible and TV1, TV9, TV14, TV16, TV18 and TV25 were fairly resistant to red spider mite infestation. No infestation was observed on TV4, TV8, TV17 and TV28, and thus these clones were found to be fairly resistant to red spider mite infestation (Table - 1).

Table 1: Inter-clonal variation in red spider mite infestation

Category	Clone (s)	Mean percentage of infestation
Highly susceptible clones	TV19	70
	TV20	80
Fairly susceptible	TV22	65
	TV24	65
	TV7	60
	TV23	60
Moderately susceptible	TV11	50
	TV26	50
Fairly resistant	TV 9	25
	TV 1	20
	TV16	15
	TV18	15
	TV25	15
	TV14	10
Highly resistant	TV 4	0
	TV 8	0
	TV17	0
	TV28	0
CV%	**7.83**	
F value (for treatment)	**118.59**	
CD at 5%	**7.49**	
CD at 1%	**10.04**	

Population survey

Seasonal fluctuation of population: - Population variation was observed throughout the year i.e., from January to December. From January till June, the population of red spider mite increased gradually, while from July onwards, a decline in population was observed and this trend continued till December (Fig.–2, bar chart)

Seasonal factors on population dynamics of red spider mite under the agro-climatic conditions of Barak Valley:

Temperature was found to have a direct relationship with the population/infestation of red spider mite.

TABLE: 2/A. Effect of pesticides (inorganic & organic) on the infestation caused by Red Spider Mite.

FIRST YEAR

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
CONTROL	0	10	25	68	107	83	40	45	13	8	3	3
ETHION	0	0	18	62	76	43	40	28	5	0	0	0
ETHION+SULFEX (1:1)	0	0	15	57	75	58	38	28	18	5	2	1
ETHION+NEEMOX(1:1)	0	0	8	18	40	43	35	30	18	5	3	0
SULFEX	0	0	12	45	81	33	30	28	8	0	0	0
ACHOOK	0	0	22	60	94	53	38	43	13	3	0	0
BIOMEEM	0	0	21	42	69	55	40	40	13	3	0	0
NEEMOX	0	0	19	58	63	18	23	45	15	0	0	0
C.V.(%)	**0**	**0**	**21.2**	**15.5**	**19.5**	**43.1**	**33.9**	**34.1**	**95.4**	**188.1**	**365.7**	**94.4**
F. Value (for treatment)	**0**	**0**	**11.3***	**20.3***	**9.5***	**4.3***	**1.3**	**2.2**	**0.7**	**1.4**	**0.7**	**25.6***
C.D. (at 5%)	**0**	**0**	**4.8**	**10.2**	**19.1**	**26.8**	**15.6**	**15.9**	**15.6**	**7.1**	**4.7**	**0.6**
C.D. (at 1%)	**0**	**0**	**6.5**	**13.8**	**25.7**	**36.2**	**21**	**21.4**	**20.1**	**9.5**	**6.4**	**0.8**

*** denotes Signigicant**

An increase in population was observed with the increase of ambient temperature from January till June (Fig. 2). The coefficient of correlation (r) between Maximum temperature and pest population was found to be 0.612, while between Minimum temperature and pest population was 0.645.

Rainfall was also observed to have a positive association with the population of red spider mite. The correlation coefficient was significant ($r = 0.89$), but the regression equation showed very marginal effect ($y = 0.0872x + 3.8952$). However, heavy rainfall during the month of June dislocated the pest from their niche on the top canopy and washed them down to the lower hamper of the bushes. Thus within a short spell of time, the red spider infested ruddy brown tea fields turn green.

Control measures

A great variation was observed from year to year with highest mite population being recorded in the year one, lesser in the next year and the lowest in the 3rd year, which could be attributed to major ecological differences between the years. However, the effects of ecological factors and pesticide treatments showed similar trends, which are presented hereinafter. The prophylactic treatments with inorganic acaricides, Ethion,

TABLE: 2/B. Effect of pesticides (inorganic & organic) on the infestation caused by Red Spider Mite.

SECOND YEAR

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
CONTROL	2	5	16	29	34	25	17	22	2	1	0	1
ETHION	0	2	6	24	21	14	9	18	0	0	0	0
ETHION+SULFEX (1:1)	0	2	4	21	18	13	13	15	1	0	0	0
ETHION+NEEMOX (1:1)	0	2	6	20	19	16	16	14	1	0	0	0
SULFEX	0	1	2	19	25	15	6	11	0	0	0	0
ACHOOK	0	1	7	25	19	12	7	18	1	0	0	0
BIOMEEM	0	1	2	10	7	6	5	9	0	0	0	0
NEEMOX	0	0	3	24	20	9	2	6	1	0	0	0
C.V.(%)	**85.7**	**47.4**	**27.8**	**15.5**	**10.5**	**18.6**	**9.2**	**12.3**	**40.8**	**203.7**	**0**	**171.3**
F. Value (for treatment)	**47.6***	**16.1***	**40.6***	**14.9***	**63.6***	**23.9***	**195.9***	**48.5***	**21.8***	**2.7***	**0**	**11.9***
C.D. (at 5%)	**0.3**	**0.6**	**2.1**	**9.1**	**2.8**	**3.3**	**1.1**	**2.2**	**0.5**	**0.5**	**0**	**0.3**
C.D. (at 1%)	**0.4**	**0.8**	**2.8**	**12.3**	**3.7**	**4.5**	**1.5**	**3**	**0.7**	**0.7**	**0**	**0.4**

*** denotes Signigicant**

Sulfex, mixture of Ethion and Sulfex, organic (Achook, Bioneem and Neemox) as well as the mixture of inorganic and organic (Ethion and Neemox) were effective, though variable in their manifestation (Table - 2/A, 2/B, 2/C). Although red spider mite infestation persisted throughout the year, the peak period of pest incidence was the month of June. From the average pest population of that month during the three years under study, a clear idea of the efficacy of prophylactic treatment emerged, which also reflects in the reduction of the carried over *mite* population (Fig.-3).

Control with inorganic pesticides: - Among the inorganic pesticides, most effective was the mixture of Ethion + Sulfex, followed by Ethion, and after that Sulfex (Table-2/A, 2/B, 2/C & Fig.-3).

Control with organic pesticides: - Neemox gave the best control, followed by Bioneem, and then Achook (Table-2/A, 2/B, 2/C & Fig.-3).

Control with the mixture of inorganic and organic pesticides: - The combination of inorganic and organic pesticides (Ethion + Neemox) had very good suppressive effect on the pest, and excellent control had been achieved with the same (Table-2/A, 2/B, 2/C & Fig.-3).

Statistical calculations on each month's data on population were done which showed that

TABLE: 2/C. Effect of pesticides (inorganic & organic) on the infestation caused by Red Spider Mite.

THIRD YEAR

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
CONTROL	1	2	7	12	32	33	26	12	3	1	1	2
ETHION	0	0	0	0	1	1	1	0	0	0	0	0
ETHION+SULFEX (1:1)	0	0	0	0	0	0	0	0	0	0	0	0
ETHION+NEEMOX (1:1)	0	0	0	0	0	0	0	0	0	0	0	0
SULFEX	0	0	0	0	3	1	1	0	0	0	0	0
ACHOOK	0	0	0	0	1	0	0	0	0	0	0	0
BIOMEEM	0	0	0	2	16	30	23	10	2	1	0	0
NEEMOX	0	0	0	0	0	0	0	0	0	0	0	0
C.V.(%)	**171.3**	**85.7**	**55.7**	**31.9**	**35**	**19.6**	**25**	**39**	**82**	**119.8**	**171**	**85.7**
F. Value (for treatment)	**11.9***	**47.6***	**112.9***	**245.1***	**206.5***	**348.2***	**209.7***	**123.5***	**22.6***	**10.6***	**11.9***	**47.6***
C.D. (at 5%)	**0.3**	**0.3**	**0.7**	**0.8**	**2.5**	**2.4**	**2.4**	**1.4**	**0.8**	**0.4**	**0.3**	**0.3**
C.D. (at 1%)	**0.4**	**0.4**	**1**	**1.1**	**3.4**	**3.2**	**3.2**	**1.9**	**1**	**0.6**	**0.4**	**.4**

denotes Signigicant

almost all the acaricides (inorganic / biopesticides / mixture of inorganic and biopesticides) helped significantly in reducing the pest population.

DISCUSSION

productivity. The well shaded sections of the valley, in general, harbour high percentage of pest free healthy plants as compared to unshaded / poorly shaded areas. This is particularly true in respect of the damage caused by red spider mite in the tea growing areas of Barak Valley where, in an earlier study, the well shaded areas were observed to have little or no red spider mite infestation (Choudhury, 1999).

Application of some neem based organic manure (Suryakhool) showed a substantial 4increase in crop production, especially during the first three to four months after their spray. Choudhury (1999) has reported that mulching helped in minimizing the severity of infestation by some other pests (termites in particular). However, no significant relationship was observed with manuring and other cultivation practices on red spider mite infestation.

On the basis of a study on soil chemical and nutrient status in tea plantation areas of Barak valley (Assam), Choudhury and Dutta (2005) have reported that the chemical

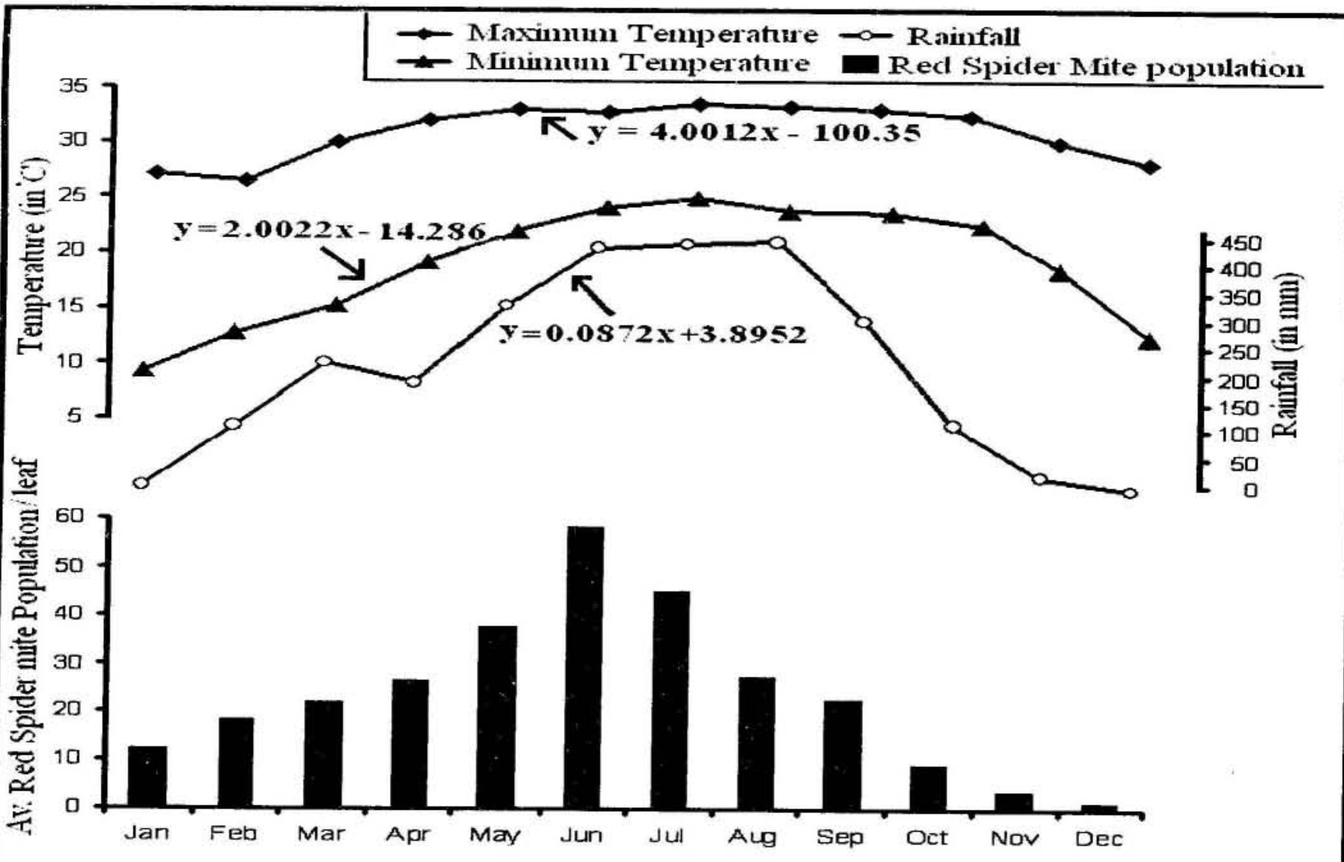

Fig: 2. SEASONAL VARIATION OF RED SPIDER MITE IN RELATION TO ENVIRONMENTAL FACTORS.

status / fertility of different tea soils of Barak valley was found to be more or less similar; with limited range of variations. On a comparative study of the physico-chemical properties of the tea soils and incidence of pests, it has been observed that pest population was not dependent on the chemical analysis on fertility status in general.

Banerjee (1989) reported that weeds have varying effects on mite population build up. In certain areas removal of weeds caused mite numbers to decline, whereas in others, their removal resulted in disappearance of mite predators and thus their regulatory effect on mites got arrested. However, pruning definitely helps to reduce red spider mite infestation as has been reported by Das (1959), where it has been mentioned that the pruned and knife cleaned tea bushes in general are least affected by red spider mite.

In the present study, red spider mite populations were recorded almost throughout the year. However, the peak period of mite population recorded during May to July and the second outbreak (slightly less than the first) was observed during the month of August/September (Fig.-2). With the onset of monsoon rains in June/July, the ruddy brown color of the mite infested bushes changes to green because the red spider population on the bush surface is sharply reduced in the upper hamper of the affected tea bushes. The mites are washed down to the lower

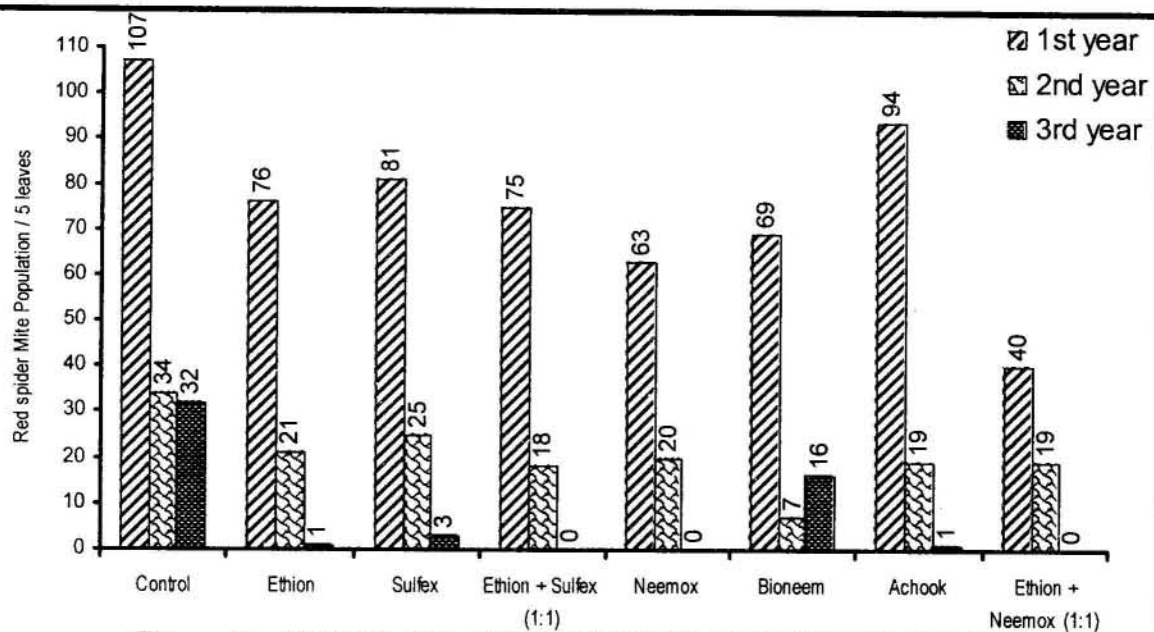

Fig . - 3: IMPACT OF PROPHYLACTIC TREATMENT ON MITE POPULATION DURING PEAK MONTH OF INFESTATION (i.e.,JUNE)

hamper of the tea bushes, where they cling during heavy rains with microscopic rammer shaped sensilla chaetica that are present on the apical end of their appendages, and migrate to the upper canopy after the rains stop (Choudhury *et al*, 2001).

Red spider mite population was significantly correlated to temperature. This aspect of mite ethology could also be explained in the light of SEM studies on the morphology of the pest as reported earlier (Choudhury *et al*, 2001), 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 dorsal surface of the tea leaves when the ambient temperature is high and therefore the pest occurs in large numbers causing major damage during the summer months.
The heavy intensity of sunlight during summer, again, is associated with location of the mite population, presumably because of their intolerance to high light intensity. The wavy striations of alternate electron dense and electroluscent bands that are raised from the general cuticular plane, with more or less uniform periodicity and height might are photosensitive and act as anti-reflection device. Being sensitive to high intensity sunlight, some of the pest populations migrate to the lower hamper of the bush frame (Choudhury *et al*, 2001).

The average red spider mite population/leaf was observed to be well above the critical threshold value of 2-3 mites/leaf (Banerjee, 1971). Highest population (i.e., 58 per five leaves) was observed during the month of June. In general, mite population increases during the summer months when the ambient temperature is high and the population is reduced during monsoon. A second but relatively small increase in population may occur during dry period. This observation is in conformity with the findings of Banerjee (1975). However, a general decline in pest activity during winters can be linked with the onset of dormancy of tea in northeast India (Baruah, 1969).

For the control of red spider mite, amongst all the inorganic and organic pesticides, the long term effect of Neemox (a neem based product) was observed to be the best (Table 2/A, 2/B, 2/C & Fig.-4).

Baruah (1969) reported that mites continue to persist on un-pruned and skiffed teas in varying numbers throughout the cold weather. In the present work, two prophylactic sprays at one month's interval during the winter months were found to be more effective against mite population build up during the main season and gave better control of red spiders during their season of occurrence as it helped to reduce the carried over population from the earlier season, which otherwise would have been instrumental in increasing the mite population/severity in the subsequent years. Foliar applications are usually carried out soon after plucking. Consequently these insecticides /acaricides get deposited on the maintenance foliage and also on the shoots which are in varied degrees of growth (Muraleedharan, 1992). This often causes residual toxicity in the made tea. The inorganic pesticides, besides leaving pesticide residues, also kill the existing micro fauna of tea soil, some of which are beneficial and decompose insoluble manures for improving nutrient availability to the plant, reflecting on the growth and productivity of tea. To overcome these problems associated with inorganic, organic pesticides or biocides are widely used in agriculture and may be adopted for tea as well (Choudhury *et al.*, 1998).

In the present study, almost all the bio-pesticides (Organic acaricides) were found to give good performance in bringing down the severity of infestation under control. These observations suggest that the biocides can be used in tea fields as efficient alternative to their inorganic counterparts for controlling mites. Being biodegradable, they can be conveniently used in combination with the traditional inorganic pesticides. This, as an aid in IPM strategy, should also help to reduce the total quantum of inorganic pesticides used in tea agro-ecosystem, which is immensely desirable.

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REFERENCES

Banerjee, B. (1965), " Mites of tea and ancillary crops ", *Two bud*, Vol. 12 (1), pp 4-7

Banerjee, B. (1971), "The threshold value in mite pest control", *Two bud,* 18 (1), pp 20-21

Banerjee, B.(1975),"Consideration in integrated control for mite pests of tea" *Proc. Tocklai Conference, 27,* pp. 110-115.

Banerjee, B. (1989), "Ecology of mites", *An introduction to agricultural Acarology*, Associated Publishing Co. New Delhi (India).

Barua, D.N. (1969),"Seasonal dormancy in tea, *Camellia sinensis* (L)", *Nature*, 224, p.514

Choudhury, P., Dutta, B.K. and Bhattacharjee, P.C. (1998) "Potential of organic pesticides in the management of insect pests in the tea agroecosystems", *Seminar on Environmental problems in North-east India,* 6-7 November,1998,p 5-6

Choudhury, P (1999), "Studies on the pests of *Camellia sinensis* L (O) Kuntze and their control in the tea agro-ecosystem in Barak Valley, Assam (Ph. D thesis), Dept. of Zoology, Gauhati University, Assam p-43-56.

Choudhury, P., Dey, S., Dutta, B.K. and Bhattacharjee, P.C. (2001) "Ultra-structural details of the morphological adaptations of some tea pests of Assam (India)", *Entomon* 26 (3 & 4),p 227-238

Choudhury, P. and Dutta, B. K. (2005),"Observation on soil chemical and nutrient status in tea plantation areas of Barak valley". *Indian J. Environ & Ecoplanning.* Vol-10 (3) p-799-802

Das, G. M. (1959), "Bionomics of the tea red spider, *Oligonychus coffeae* (Nietner). *Bulletin of Entomological research*, 50: 265-274.

Das, G. M. (1963) "some important pests of tea", *Two and a bud* X (2):p 4-8

Das, S. C., Mukherjee, S., Gope, B. and Satyanarayana, G. (1982) "Termites in Cachar – an ecological study" *Two and a bud* 29 (1): p3-4.

Ma, E. P. and Yuan, I.L. (1976), "On the genus *Oligonychus berlese* from China (Acarina: Tennipalpidae), *Acta ent. Sinila,* 19(3), p 357-362

Muraleedharan N (1992), "Bioecology and management of tea pests in Southern India", *Journal of Plantation crops,* 20(1), p 1-21

Muraleedharan, W (1983), "Tea entomology – an overview", *Occasional publication UPASI, Tea Research Institute, Coimbatore,* India, p-32

Sarkar, A. R. (1977), "A sampling method for estimating the infestation of red spider mite on tea", *Two Bud,* Vol. 24(1), p-10-1.