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Comparison of the Effect of Two Different Synthetic Acaricides on the Population Dynamics of Red Spider Mite (*Oligonychus coffeae*) in Two Different Tea Gardens of Terai Region, Darjeeling District, West Bengal, India

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#### ABSTRACT

Tea (Camelia sp.) is infested by red spider mites (Oligonychus coffeae Nietner) causing reddish spots by sucking cell sap of mature tea leaves. Four mites per tea leaf is the economic threshold level. To control this pest several synthetic acaricides are regularly used in the tea plantations. In two tea gardens of Terai region, Kiranchandra Tea Estate and Sukna Tea Estate the mite population was determined in terms of mites per leaf. The population size was well above the threshold level in both the gardens and was increased in greater extent in Kiranchandra Tea Estate in comparison to Sukna Tea Estate over seven days without the treatment of any acaricide. However, under the treatment of two commonly used acaricides, Hexythiazox and Propargite, the mite population was decreased significantly in both tea plantations.

Key words: Tea, Red spider mite, Oligonychus coffeae, Hexythiazox and Propargite.

#### INTRODUCTION

Tea (*Camelia sp.*) is the economic life line of a large section of people from North Bengal and North East India. Tea from Darjeeling district has gained geographical indicator (GI) status. However, tea is regularly infested by more than 300 species of animals including insects, mites and nematodes (Das 1965, Hazarika *et al.* 2009). Red spider mites (*Oligonychus coffeae* Nietner) are 4-pair-legged creature belonging to the family Tetranychidae under Sub-class Acari and class Arachnida. These are generally found on the dorsal surface of maintenance tea leaves, located below the plucking surface and feeds on the cell sap by puncturing upper surface of mature tea leaves. The attack starts along the midrib, veins, on the depression of leaves and gradually spreads to the whole leaf (Barua 2008). Reddish spots develop on sucking sites which later on unite to form large brown patches (Anonymous 1994).

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The maintenance foliage turns ruddy bronze, making the infested fields distinct even from a distance (Muraleedharan 1991). In severe attack leaves may dry up & fall off. 4 mites/ leaf is the economic threshold level for mites (Kabir and Das 2015a). The damage caused by mites can often lead to the significant impact on the productivity as well as on the quality of tea leaves. The magnitude of the pest infestation depends on the altitude, climate, plant variety & cultural practices. The infestation of red spider mite is responsible for huge economic loss in all tea plantations of Terai region particularly in dry season.

Pest control in tea is mainly achieved by the use of synthetic pesticides. There are several acaricides in the market manufactured by different pesticide companies. However considering the human health, Tea Board approved some of the acaricides in Plant Protection Code (PPC) in 2014 (Kabir and Das 2015a). Among several approved acaricides Hexythiazox and Propargites are most widely used in the tea plantations of Terai region.

In this present study a survey was undertaken during the dry season to document the pest infestation caused by the red spider mites under the treatment of these two mostly used pesticides. For this purpose 2 tea estates were selected in the Terai regions which are distantly located along the east-west belt of sub-Himalayan tea plantations. Then the pest infestation status under the treatment of two pesticides was compared by t-test and ANOVA using SPSS statistical software to compare the effect of these two pesticides on the infestation of red spider mites.

#### MATERIALS AND METHODS

The experiment was conducted in Kestapur section 23/C (26.70 N, 88.28 E) of Kiranchandra Tea Estate (Garden 1: G1) and section 41 (26.77 N, 88.38 E) of Sukna Tea Estate (Garden 2: G2) in the Terai region of Darjeeling District of West Bengal. The tea plants of these two plantations were of Cambod variety (Camelia assamica ssp. lasiocalyx) having boat shaped, pale green coloured leaves with pink base of petiole due to anthocyanin pigmentation (Kabir and Das 2015b). In Kiranchandra Tea Estate, the tea plants had grown from the seed variety TS 462 whereas in Sukna Tea Estate the plants were propagated from the clone variety TV 18, 25 and 26 (Das and Konwar 2011, Konwar 2011). The infestation of red spider mites (Oligonychus coffeae Nietner) was compared under the treatment of two PPC-approved acaricides. In treatment 1(T1), Hexythiazox 5.45% W/W EC (Brand name: Maiden) was used at 0.8 ml/litre dose, whereas, in treatment 2 (T2), Propargite 57% EC (Brand name: Admite) was used at 1.5 ml/litre dose (Kabir and Das 2015a). In each tea plantation 9 plots of 9 square meters in area having 12 bushes were taken for control and two pesticide treatments each with 3 replications (Sarkar et al. 2016). The experiments were laid out in Randomized Block Design (RBD) (Figure 1 and 2). Hundred leaves were taken randomly from each plot before insecticide spray (pre-treatment). The leaves were pressed against a small piece of blotting paper so that the mites left impression on the paper being smashed and the red spots were counted. Therefore, the number of live red spider mite was counted indirectly by counting the red impression marks on the blotting paper using magnifying glass. During treatment, the bushes of the plots marked for control (C) were sprayed with water whereas the plots specified for two different pesticides (T1 and T2) were sprayed with Hexythiazox & Propargite accordingly. After 7 days of treatment, another observation was taken (post-treatment) in the same method. Statistical analyses were done using computer software IBM SPSS 21. The number of mites counted per leaf was compared between observations during pre- and post-treatment in case of control, treatment 1 and treatment 2 separately in each of the two plantations by unpaired t-test. The level of pest infestation was further compared among control, treatment 1 and treatment 2 within each tea garden by one-way ANOVA.

#### RESULT

The average number of red spider mite per leaf was increased significantly in 7 days in tea plantations of Kiranchandra Tea Estate without any pesticide treatment (G1: t= -2.44, df= 598, p= 0.014);

however, in Sukna Tea Estate the increase was non-significant (G2: t= -1.217, df= 598, p= 0.614). The level of increase was very high (59.74%) in garden 1, whereas, in garden 2 the increment was low (14.21%) (Table 1, Figure 3). When Hexythiazox was used, the pest population in terms of mites per leaf was decreased significantly in 7 days in both tea plantations (G1: t= 4.072, df= 598, p<0.001; G2: t=8.978, df= 598, p<0.001). In garden 1, the mites were decreased by 60% and in garden 2 by 84.42% (Table 1, Figure 3). Similarly when Propargite was used, the mite population was also decreased significantly in both plantations (G1: t=3.355, df=598, p<0.001; G2: t=9.835, df=598, p<0.001). In garden 1 the mites were decreased by 79.41% (Table 1, Figure 3).

In Kiranchandra Tea Estate, it was found that there is a significant variation in the mites per leaf when control, treatment 1 and treatment 2 were compared by one-way ANOVA testing [F=8.754, df=1799 (between groups 2 and within groups 1797) p<0.001]. By Tukey test, it was found that though there is a significant mean difference between control and treatment 1 and control and treatment 2, but the mean difference between treatment 1 and treatment 2 is not significant.

In Sukna Tea Estate, there is a significant variation in mite population under control, treatment 1 and treatment 2 (F=20.784, df=1799, p<0.001). Here also the mean difference between the control and treatment 1 as well as the control and treatment 2 is significant, but the mean difference between treatment 1 and treatment 2 is not significant.

#### DISCUSSION

The study of the infestation of red spider mites during pre-treatment in two different tea plantations of Terai region revealed that the experimental section of Sukna Tea Estate is heavily infested by red spider mite (18.3/leaf) in comparison to the Kiranchandra Tea Estate (7.7/leaf). However, an interesting scenario came out from this survey that in Kiranchandra Tea Estate the mite population had expanded significantly in 7 days whereas there was no significant increase in population size in Sukna Tea Estate. One possible reason may lie in the population dynamics of mites. As in the experimental section of Sukna, mite population was high during first trial which probably reached the threshold level of carrying capacity, so during second trial the population size could not expand significantly. Another reason of insignificant increase in mite number in Sukna obviously lies in the garden management strategies. In Sukna, the garden was well maintained; the weeds were periodically cleaned, hedge plants were present along the road side and the drainage system was well and good. Moreover, the experimental section was shaded by long shade trees. All those conditions are responsible for lower expansion of mite population size.

BLOCK-1	BLOCK-2	BLOCK-3
C	T <sub>1</sub>	T <sub>2</sub>
BLOCK-4	BLOCK-5	BLOCK-6
T1	T <sub>2</sub>	C
BLOCK-7	BLOCK-8	BLOCK-9
T <sub>2</sub>	C	T <sub>1</sub>

Figure 1. Randomised block design (RBD) for the study of Kiranchandra tea estate (C= Control, T<sub>1</sub>= Treatment 1 with Hexythiazox pesticide, T<sub>2</sub>= Treatment with Proparzite pesticide).

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BLOCK-1	BLOCK-2	BLOCK-3
T <sub>1</sub>	C	T <sub>2</sub>
BLOCK-4	BLOCK-5	BLOCK-6
T <sub>2</sub>	T <sub>1</sub>	C
BLOCK-7	BLOCK-8	BLOCK-9
C	T <sub>2</sub>	T <sub>1</sub>

## Figure 2. Randomised block design (RBD) for the study of Sukna tea estate (C= Control, T<sub>1</sub>= Treatment 1 with Hexythiazox pesticide, T<sub>2</sub>= Treatment with Proparzite pesticide.

During this study, it was also found that in both plantations the mite attack have crossed the economic threshold level (4 mites/ leaf). So, it is necessary to control these pest populations immediately by using acaricides, otherwise severe infestation in these plantations may lead to the huge economic loss. In this study two widely used synthetic pesticides Hexythiazox and Propargite were applied separately in different plots of the section. According our expectation, both the pesticides lowered the mite population significantly in both sites. So, both these pesticides are well effective against the red spider mite. Hexythiazox is the growth inhibitor and successfully lowers the pest population by interfere their developmental process. On the other hand, Propargite acting as mitochondrial ATP synthase inhibitor efficiently decrease the mite population size by shut down the energy production system (Anonymous 2010). However, the effectiveness of Hexythiazox as well as Propargite was not significantly different among two plantations. So, these two acaricides can be used alternatively in both plantations to control the mite infestation.



Figure 3. Comparison of the average number (mean <u>+</u> standard error) of red spider mite per leaf during pre- and post-treatment (Garden1= Kiranchandra Tea Estate, G2= Sukna Tea Estate; C=control, T1=Hexythiazox treatment, T2= Propargite treatment).

I I									
	KIRANCHANDRA			SUKNA					
	Pre	Post	%	Pre	Post	%			
	Treatment	Treatment	Difference	Treatment	Treatment	Difference			
	(a)	(b)	<u>(b-a) x 100</u>	(a)	(b)	<u>(b-a) x 100</u>			
			а			а			
CONTROL	7.7 <u>+</u> 1.14	12.3 <u>+</u> 1.49	59.74	18.3 <u>+</u> 1.47	20.9 <u>+</u> 1.38	14.21			
(Untreated)									
TREATMENT-I	8.5 <u>+</u> 1.05	3.4 <u>+</u> 0.68	-60.00	19.9 <u>+</u> 1.77	3.1 <u>+</u> 0.61	-84.42			
(Hexythiazox 5.45%)									
TREATMENT-II	8.5 <u>+</u> 1.16	3.9 <u>+</u> 0.72	-54.12	20.4 <u>+</u> 1.53	4.2 <u>+</u> 0.63	-79.41			
(Propargite 57%)									

 Table 1. Comparison of the average number (mean <u>+</u> standard error) of red spider mite per leaf during pre- and post-treatment.

#### CONCLUSION

From this study it was found that in untreated condition mite population is increased heavily depending on the population size as well as on the management strategies of the garden. To control these pests, both Hexythiazox and Propargite can be used along with maintaining the tea plantation in good condition. Hexythiazox and Propargite are equally effective against the mite population, so these two pesticides can be used alternatively to prevent the development of resistance against the particular pesticide.

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