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Studies on ovicidal activities of selected acaricides against *Oligonychus coffeae* Nietner on tea

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Abstract
Tea red spider mite, *Oligonychus coffeae* is one of the most serious acarine pest of tea, causing considerable loss to the tea industry. Acaricides are the first choice to manage this pest particularly in case of severe incidence. In spite of regular application of acaricides, red spider mite is still a year round menace in tea gardens. Under this situation, tea gardeners usually prefer acaricides having ovicidal action because it controls the pest at very initial stage *i.e* egg stage. There are very few research reports on ovicidal activity of acaricides against tea red spider mites. So an experiment was conducted to evaluate the ovicidal activity of nine selected acaricides against tea red spider mite. It was found that Fenazaquin 10 EC, propargite 57 EC, Hexythiazox 5.45 EC, Etoxazole 10 SC, cyflumetofen 20SC and spiromesifen 22.9 SC exhibited cent per cent ovicidal activity. Sulphur 80WDG found to have almost no ovicidal action (0.67%).

Keywords: *Oligonychus coffeae*, Ovicidal activity, Cyflumetofen 20SC, Spiromesifen 22.9 SC, etoxazole 10 SC

Introduction
Tea is one of the most popular non alcoholic drinks all over the world because of its stimulant properties as well as numerous health benefits [1]. Although many people start the day with bed tea but it is also considered as "any time of the day" drink. Due to its high demand, tea is grown in different countries of the world including India. India is the 2nd largest producer of tea in the world after China and produced about 1338.63 million Kgs of tea during the calendar year 2018 [2]. In India the largest tea producing states are Assam, West Bengal, Tamil Nadu, Kerala and Karnataka. Tea industry is the combination of both agriculture and industrial sectors. This is the only industry where India has retained its leadership over the last many years due to its unique quality of tea. Tea industry plays an important role in the national economy of India in terms of income generation, earning foreign exchange, employment generation and contribution to the national exchequer. India plays a significant role in the world tea trade being the world's second largest producer of tea. In spite of all these things, there are many production constraints. About 80% of the total tea produced in India is consumed by the domestic population [3]. So, to retain and improve our position in the world market we have to increase our productions as well as we have to maintain a consistently high quality especially in view of new competition emerging in the international tea trade.
Among various production constraints, infestation of arthropod pest is one of the most important factors which attract special attention of the growers. Being an 'evergreen, perennial and monoculture crop, tea is infested by numerous arthropod pests' [4] causing considerable yield loss every year. 'Mites, as a group, are persistent and the most destructive pests of tea in almost all tea producing countries of the world' [4, 5]. *Oligonychus coffeae*, popularly known as red spider mite is a major concern among the growers because of its potentiality to cause about 17 to 46% yield loss [6]. They remain confined mainly on the upper surface of matured leaves and as a result of their feeding the infested leaves turn reddish bronze in colour affecting the photosynthetic activity of the plant. In case of severe infestation, the infested field can even be identified from distance. Growers usually rely on acaricides to manage this acarine pest in tea gardens. But the problem is that in spite of regular application of acaricides, red spider mite is still a year round menace in tea gardens particularly in Terai and Doors of West Bengal. Even control failure has also been reported and this may be due to development of acaricide resistance. Considering all these things growers now usually prefer acaricides having ovicidal properties because it control the pest in the very initial stage *i.e* egg stage and thereby limit the next progeny.

But the recent research reports on in-depth study of ovicidal action of acaricides on *Oligonychus coffeae* are limited as majority of the research reports are on the motile stage of the pest. So, the present experiments were conducted to bridge this gap.

Materials and Methods

Maintenance of red spider mites under laboratory condition

Initially the red spider mite culture was collected from Tea Research Association, Nagrakata Sub-station, Jalpaiguri, West Bengal, India. This culture of red spider mite was maintained in the laboratory at 25 ±2ºC and 70 - 80% relative humidity by following detached leaf culture method of Helle and Sabelis [7] with slight modifications. Withered leaves were replaced with new ones, at 4 days interval. The eggs laid by the laboratory reared mites were used for the present study. The whole experiment was conducted in the laboratory of Department of Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India.

Acaricides used in the experiment

Nine acaricides were used for the study. These acaricides are usually recommended for management of mites in the tea garden. Details of the acaricides used are presented in Table 1.

Ovicidal Activity

Matured tea leaves were collected from the garden. The collected leaves were then washed thoroughly in laboratory using tap water. The washed leaves are then dried in normal room temperature. After drying, leaf discs of 2.5cm diameter was cut from the whole leaves and were placed on water soaked cotton pad which was kept on a petriplate of 15 cm diameter. Fifteen adult females of *Oligonychus coffeae* were then released on these leaf discs using a moistened eyebrow hair brush. The introduced adult female mites were allowed for oviposition on the leaf disc overnight to obtain eggs of uniform age. Then, they were removed from the disc using the same brush and the numbers of eggs laid on the leaf discs were counted under a stereo-binocular microscope as pretreatment count. Only thirty eggs were kept on each leaf disc and the excess eggs were removed very carefully using a fine needle. These thirty eggs on the leaf discs were sprayed with selected acaricides at recommended doses with a glass atomizer. Water was sprayed in control. The treated eggs on the leaf discs were then dried in normal room temperature and after drying of the leaf discs, the petri plates were kept under controlled laboratory condition. There were five replications of each treatment and the whole experiments were repeated thrice. Observation on the number of eggs hatched was recorded for a period of twelve days after oviposition. The eggs which did not hatch after this period were considered as non-viable [8].The per cent reduction in hatchability was expressed as per cent mortality of eggs at each treatment and was calculated by using the following formula [9].

$$\text{Per cent reduction in hatchability} = \frac{\text{Number of unhatched eggs/treatment}}{\text{Total number of eggs/treatment}} \times 100$$

Table 1: Details of acaricides used in the present laboratory experiment.

Acaricides	Trade name	Class	Application rate	Manufacturer/suppliers
Fenazaquin 10 EC	Magister	Quinazoline group	2.5 ml/L	E. I. Dupont Industries Pvt. Ltd
Propargite 57 EC	Omite	Sulfite Ester Group	1.9 ml/L	Dhanuka Agritech Ltd
Fenpyroximate 5 EC	Mitigate	Pyridazinones	0.75 ml/L	Isagro Asia
Hexythiazox 5.45 EC	Maiden	Thiazolidine Group	0.68 ml/L	Biostad India Ltd.
Spiromesifen 22.9 SC	Oberon	Tetronic Acid Derivatives	1 ml/L	Bayer Crop Science
Etoxazole 10 SC	Borneo	Diphenyl oxazoline	1 ml/L	Sumitomo Chemical Co. Ltd
Cyflumetofen 20SC	Foster	Benzoyl acetonitrile	1.56 ml/L	Dhanuka Agritech Ltd
Sulphur 80WDG.	Parsul	Sulphur	5 g/L	Parijat Industries India Pvt. Ltd.
Dicofol 18.5 EC	Colonel S	Organochlorine	2.5 ml/L	Indofil Industries Limited

g-gram; L-liter; EC-emulsifiable concentrate; SC-suspension concentrate, WDG-Water Dispersible granule.

Statistical analysis

Data regarding per cent mortality of eggs of red spider mite were subjected to analysis using analysis of variance (ANOVA) after making necessary transformation and means were separated by Duncan's multiple range test (DMRT). Mortality in the control was corrected using Abbott's formula [10]. Means (±SEm) of untransformed data are reported.

Results and Discussion

The results of the present experiments on the bio-efficacy of different acaricides on the eggs of RSM are given in Tables 2.

Table 2: Ovicidal efficacy of selected acaricides against red spider mite (*Oligonychus coffeae*) on tea under laboratory condition.

Acaricides	Mean per cent ovicidal action (Mean±SE)
Fenazaquin 10 EC	100.00±0.00^{a}
Propargite 57 EC	100.00±0.00^{a}
Fenpyroximate 5 EC	56.83±0.38^{b}
Hexythiazox 5.45 EC	100.00±0.00^{a}
Sulphur 80WDG	0.67±0.01^{c}
Dicofol 18.5 EC	20.98±0.71^{d}
Etoxazole 10 SC	100.00±0.00^{a}
Cyflumetofen 20SC	100.00±0.00^{a}
Spiromesifen 22.9 SC	100.00±0.00^{a}
Control	0.00 ± 0.00^{c}

NB. Means followed by the same letter do not differ significantly at $P = 0.05$ according to DMRT

The results of the present study revealed that except sulphur 80 WDG all the acaricides exhibited significantly higher ovicidal properties compared to control. Of the nine acaricides used in the experiment, six acaricides *viz*., fenazaquin 10 EC, propargite 57 EC, hexythiazox 5.45 EC, etoxazole 10 SC, cyflumetofen 20SC, spiromesifen 22.9 SC exhibited cent per cent inhibition of the hatching at the recommended of eggs of *T. urticae* based on the 10th day observations under laboratory condition. Eggs of *T. macfarlanei* and *T. truncates* were reported to be highly susceptible to the acaricides *viz*., spiromesifen and hexythiazox, at the LC_{50} level [11]. In our present study fenazaquin 10 EC, a quinazoline class of chemicals exhibited cent per cent inhibition of egg hatching. The high level of egg mortality exhibited by this chemical was also reported by many researchers. Awasthi and Bhaskar in '2013 [12] reported that fenazaquin 10EC excelled in ovicidal activity with a mean egg mortality of 94.21% within 72 hours of treatment application in *T. urticae*. They also reported that spiromesifen 240 SC exhibited 90.21% ovicidal effect in the same experiment'.

The acaricides, except sulphur and fenpyroximate, used in the present study found to have excellent ovicidal effect on eggs of the red spider mite. One possible explanation for this could be the high active ingredient (ai) of the acaricides or innate toxicity of the molecules. The mortality can be attributed to the direct contact of the newly emerged nymphs to the acaricides or there might be some adverse effects on the development of the eggs.

But sulphur 80WDG found to have almost no ovicidal action. Almost similar findings on the ovicidal activity of the present acaricides except cyflumetofen 20SC were reported by Sarmah *et al.*, 2016 [10]. All the eggs in untreated control hatched into nymphs and there was no nymphal mortality. To the best of our knowledge, there are limited studies regarding the ovicidal effect of acaricides against *Oligonychus coffeae* and most reports have been focused on the control of motile stages. So our present findings may be compared with the ovicidal activities of these molecules against other mites. Kumari *et al.*, 2017 [13] reported that 'spiromesifen 22.9 SC, a tetronic acid derivative exhibited cent per cent mortality'.

The result of the present study revealed that fenazaquin 10 EC, propargite 57 EC, hexythiazox 5.45 EC, etoxazole 10 SC, cyflumetofen 20SC and spiromesifen 22.9 SC exhibited cent per cent ovicidal activity. So these acaricides may be used rotationally for effective management of red spider mite in tea ecosystem.

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