# STATUS OF NEW ACARICIDES VIS-A-VIS CONVENTIONAL ACARICIDES AGAINST THE RED SPIDER MITE, *OLIGONYCHUS COFFEAE* (ACARINA: TETRANYCHIDAE) IN TEA PLANTATIONS OF DARJEELING PLAINS, INDIA

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**Abstract:** The Red spider mite, *Oligonychus coffeae* (Acarina: Tetranychidae), is the most destructive pest of tea. In the present experiment, the status of new acaricides vis-à-vis conventional acaricides in Darjeeling plains population of *O. coffeae* was estimated. The $LC_{50}$ (expressed in ppm) values of ethion, dicofol, profenofos, propargite, fenpropathrin, fenpyroximate, fenazaquin and abamectin were 687.18, 534.04, 241.684, 90.256, 12.549, 6.196, 4.319 and 2.405 respectively. Of all the acaricides tested abamectin is the most toxic and ethion was the least toxic. The $LC_{95}$ (ppm) values were also calculated. This kind of study would serve as ready-reckoner of the selection of acaricides for the management of field strains and also helpful in development of resistant management strategies for this important polyphagous mite pest.

**Key words:** *Oligonychus coffeae*, acaricides, Darjeeling plains population.

## INTRODUCTION

The red spider mite (RSM), *Oligonychus coffeae* Neitner belongs to the group of acarines known as Acariformes, in the suborder Prostigmata, and the family Tetranychidae. The RSM is a pest of broad-leaved evergreens, reported from 14 countries in four continents and feeding on 34 different plant species of 15 families (Borrer *et al.,* 1989). Red spider mite is a major arthropod pest that attacks most tea cultivars of Darjeeling foothills and their plains comprising Terai and Dooars plantations of North-East India (Anonymous, 1994). The average annual consumption of insecticide and acaricide in Dooars and Terai is 7.05 and 3.49 kg / lt / hectare respectively (Barbora and Biswas, 1996). Among the synthetic pesticides ethion & dicofol are preferred as acaricides. Recent information available indicates that the pesticides (insecticide and acaricide) consumption has increased in Terai as well as in Dooars tea plantations, 85% of the acaricides being used between the month of January and June (Sannigrahi and Talukdar, 2003). In spite of the use of synthetic pesticides, such as organochlorides and organophosphates the red spider mite (RSM) remains a serious problem of tea and a difficult pest to control. Many workers have reported that management of *O. coffeae* has become a challenge apparently due to higher tolerance (Das, 1959; Banerjee, 1968). The extensive use of acaricides such as, dicofol and ethion in tea for more than a decade has probably led to pesticide resistance in red spider mite (Sahoo *et al.,* 2003; Roy *et al.,* 2008). So there is a need to study the status of new molecules vis-à-vis with old groups of acaricides especially synthetic pyrethroids. Such kind of studies will be helpful in using different group of molecules with care and preserving the usefulness of insecticides in pest management programme, and in further delaying the development of resistance in the meantime. Keeping these things in view, the present studies were contemplated to determine the relative toxicity of synthetic molecules with diversified modes of action against this pest in laboratory to provide organized guidance for the selection of insecticides that can be incorporated in pest management programmes. The $LC_{50}$ values obtained would serve as ready reckoner for the selection of insecticides for field strains. Also, such base line data could be used as critical inputs in the deployment of new insecticides and insecticide resistance management programmes.

## MATERIAL AND METHOD

Rearing of red spider mite

A culture of red spider mite was maintained in the laboratory at 25 ± 2$^{o}$C and 70-80% RH on a susceptible tea clone, TV1 by following detached leaf culture method of Helle and Sabelis (1985) with slight modifications at Entomological Research Laboratory, Department of Zoology, North Bengal University, West Bengal, India.

Acaricides

The acaricides ethion (Ethion 50 EC : aliphatic organothiophosphate insecticides), dicofol (Colonel-S 18.5 EC: diphenyl aliphatics organochlorine), propargite (Omite 57 EC: organosulfurs), profenofos (Curacron 50EC: phenyl organothiophosphate), fenpyroximate (Acaban 10 EC: pyrazoles), fenazaquin (Magister 10EC: quinazolines), fenpropathrin (Meothrin 30 EC: 4$^{th}$ generation pyrethroid ester) and abamectin (Avid: antibiotics ) were obtained from respective manufacturers and used for the present study.

Estimation of relative toxicity

The log-dose-probit-mortality (LDPM) assay of afore said acaricides were used with concentrations of each test acaricides by diluting in distilled water. Toxicity assays were conducted as per the standard method, 'Leaf Dipped Method" recommended by FAO Method No. 10a (FAO, 1980). TV 1 clones mature tea leaves were collected from the experimental garden plots and brought to the laboratory. The leaves were washed thoroughly with distilled water and air-dried. Five tea leaves for each treatment were dipped up-to five seconds in the acaricides solutions to ensure complete welting and then the treated tea leaves were kept under ceiling fans for 15 minutes to evaporate the emulsion before placing dorsoventrally them in the cultural Petri dishes. Cotton wool strips, 1 cm in width, soaked in tap water were laid around the margin of each treated leaf with half over the leaf and half over the cotton wool bed. A small piece of damp cotton wool has placed around the petiole of each leaf. A population of at least 10 adult mites per leaf was released with the help of a binocular microscope or hand lens. It was necessary to ensure that there are no gaps between the leaves and cotton wool strips. Each treatment was replicated five times

The adult red spider mites were exposed initially to concentrations of a wide range, and on the basis of mortality recorded a series of concentrations of a narrow range were selected to which the test mite is again exposed. The same procedure was repeated until mortality data in the range of 10-90% was recorded. Mortality was recorded 24 hours after treatment. The moribund insects were counted as dead. The data thus obtained were subjected to probit analysis for calculating regression equation and lethal concentration by Finney's method of probit analysis (Finney, 1971). The values of relative toxicity of different acaricides were calculated by taking values of median lethal concentration of the acaricides which have high $LC_{50}$ value, as unity. This method was adopted due to the unavailability of a suitable reference susceptible strain. normally used to calculate resistance factors (Chaturvedi, 2004).

## RESULTS

The $LC_{50}$ (ppm) values of ethion, dicofol, profenofos, propargite, fenpyroximate, fenpropathrin, fenazaquin and abamectin were 687.18, 534.04, 241.684, 90.256, 12.549, 6.196, 4.319 and 2.405 respectively (Table 1). The dose mortality responses to *Oligonychus coffeae* indicated that, at $LC_{50}$ (sensitive point for relative evaluation of acaricides), out of ten acaricides tested against *O. coffeae*, all the acaricides viz., dicofol, profenofos, propargite, fenpropathrin, fenpyroximate, fenazaquin and abamectin were more toxic than ethion being 1.29, 2.84, 7.61, 54.76, 110.91, 159.11 and 285.73 times more toxic respectively.

Based on the $LC_{95}$ values, fenazaquin was most toxic and ethion was least toxic among the commonly available acaricides against *O. coffeae*, (a point which indicates the concentration required for field recommendation to manage the pest population); the relative toxicity of dicofol, profenofos, propargite, fenpropathrin, fenpyroximate, fenazaquin and abamectin were 1.71, 3.16, 36.49, 141.88, 213.24, 396.56 and 425.74 times more than ethion respectively. Among the organophosphate insecticides profenophos was more toxic to the test mite and ethion is the least toxic. Among different chemicals tested, the ethion, dicofol and profenophos compounds showed $LC_{50}$ values <240 ppm and propargite showed intermediate $LC_{50}$ value (i.e. 90.256 ppm) and all other chemicals showed $LC_{50}$ values >15 ppm.

**Table 1**

Comparative toxicity of different acaricides against *Oligonychus coffeae*

| Acaricides | Chi $^2$ | Regression equation | $LC_{50}$ | Fiducial limit | Relative toxicity | $LC_{95}$ (95%) |
|---|---|---|---|---|---|---|
| Ethion | 5.43 | y = 1.741x -5.168 | 687.18 | 802.68 549.37 | 1 | 6134.88 |
| Dicofol | 4.18 | y = 2.005 x - 6.469 | 534.04 | 599.50 475.42 | 1.29 | 3582.88 |
| Profenofos | 7.84 | Y = 1.829 x - 4.8503 | 241.684 | 311.74 187.37 | 2.84 | 1940.61 |
| Propargite | 5.817 | Y = 6.133 x – 25.393 | 90.256 | 95.09 85.66 | 7.61 | 168.10 |
| Fenpropathrin | 7.117 | Y = 3.081 x - 7.628 | 12.549 | 13.89 11.33 | 54.76 | 43.24 |
| Fenpyroximate | 0.410 | Y = 2.482 x – 4.412 | 6.196 | 7.18 5.34 | 110.91 | 28.77 |
| Fenazaquin | 3.92 | y = 2.987 x - 5.861 | 4.319 | 4.18 3.87 | 159.11 | 15.47 |
| Abamectin | 3.39 | Y = 2.129 x - 2.198 | 2.405 | 2.95 1.95 | 285.73 | 14.41 |

In none of the cases the data was found significantly heterogeneous at P = 0.05
y = Probit kill;
x = log (concentration X $10^3$),
$LC_{50}$ = concentration calculated to give 50 per cent mortality

## Discussion

In the present study abamectin demonstrated higher toxicity than other acaricides. It belongs to the Avermectins; these are a group of macro cyclic lactones isolated from fermentation of the soil microorganism *Streptomyces avermitilis*. These compounds act as agonists for gamma-amino butyric acid (GABA)-gated chloride channel. It is the most potent pesticide compound registered for agricultural use. Bioefficacy of these avermectins mainly due to their unique mode of action and lack of cross-resistance with available pesticides. These compounds are considered best for IPM programmes because of their strong physiological and ecological selectivity (Ishaya and horowitz, 1988). Fenazaquin and fenpyroximate were the other chemicals, which were found more toxic after abamectin. Fenazaquin is the member of quinazolines class of acaricides. Fenazaquin is a metabolic inhibitor that interrupts mitochondrial electron transport at Site 1. Toxicity of fenazaquin may be attributed to their novel mode of action (Ware and Whitacre, 2004).

The fenpyroximate was found more toxic in the present study which may be because it acts by inhibiting of mitochondrial electron transport at the NADH-CoQ reductase site, leading to the disruption of adenosine triphosphate (ATP) formation, the crucial energy molecule (Ware and Whitacre, 2004). Sahoo *et al.* (2003) reported that new acaricides were more toxic than conventional acaricides against *O. coffeae.* It might be mainly due to their unique modes of action and translaminar movement and lack of cross-resistance with other commercially used pesticides.

These findings do not reflect field efficacy since these are based on a linear response to a variety of dosages under laboratory conditions, where as field efficacy is influenced by several other factors including coverage and environmental conditions. Coupled with their efficacy against resistant pests and selectivity towards natural enemies, these new molecules can greatly reduce the number of sprays applied per season. Sine these new chemicals are mostly contact and stomach poisons, they are reported to be highly efficient in the field. Since growers have a wide range of alternatives in the form of old and new chemicals, the best strategy would be to use effective compounds as one of the components of pest management strategy.

**REFERENCES**

ANOANONYMOUS. (1994). Pests of Tea in North- East India and their control. In: Memorandum no 27, Tocklai Experimental Station, Jorhat, Assam, India.

BANBANERJEE, B. (1968). Insect resistance. Two and a Bud, 16(1), 13-14.

BARBARBORA, B. C. & BISWAS, A. K. (1996). Use pattern of pesticides in tea estates of North-East India. Two and a Bud**,** 43(2), 4-14.

BORROR, D. J., TRIPLEHORN, C. A. & JOHNSON, N. F. (1989). An Introduction to the Study of Insects, pp. 875. Saunders College Publishing.

CHATURVEDI, I. (2004). A Survey of Insecticide Resistance in *Helicoverpa armigera* in Central and South Indian Cotton Ecosystems, 1999 to 2003. Resistant Pest Management Newsletter, 14(1), 23- 26.

DAS, G. M. (1959) Bionomic of the tea red spider, *O. coffea* (Nietner). Bulletin of Entomological Research, 50 (2), 265 -275.

FAO (1980). Recommended methods for measurement of pest resistance to pesticides Plant Production and Protection Paper. 21, 1-132.

FINNEY, D. J. (1973). Probit Analysis. pp. 333. Cambridge University Press.

HELLE, W. & SABELIS, M. W. (1985). Spider mites : their biology, natural enemies and control. pp. 335. Elsevier Science Publishing Company INC., New York.

ISHAAYA, I. & HOROWITZ, A. R. (1988). Insecticides with novel modes of action, In: An over view Insect ides with novel modes of action ( Eds I. Ishaaya & D. Degheele), pp. 1-25. Narosa Publishing House, New Delhi.

ROY, S., MUKHOPADHYAY, A. & GURUSUBRAMANIAN, G. (2008). A preliminary toxicological study of commonly used acaricides of tea red spider mite (*Oligonychus coffee* Neitner) of North Bengal, India. Resistance Pest Management Newsletter, 18(1), 5- 10.

SAHOO, B., SAHOO S. K. & SOMCHOWDHURY, A. K. (2003). Studies in the toxicity of newer molecules against tea red spider mite, Proceeding of National Symposium on Frontier Areas of Entomological Research, pp.301-302. National Tea Research Foundation, India.

SANNIGRAHI, S. & TALUKDAR, T. (2003). Pesticide use patterns in Dooars tea industry. Two and a bud, 50, 35-38.

WARE, G. W. & WHITACRE, D. M. (2004). An Introduction to Insecticides. In: The Pesticide Book. Meister Pro Information Resources, Willoughby, Ohio.