Biocidal activity of certain indigenous plant extracts against red spider mite, *Oligonychus coffeae* (Nietner) infesting tea

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ABSTRACT

Red spider mite (RSM), *Oligonychus coffeae* is one of the major pests of tea in south Indian tea plantations. The modern usages of various synthetic chemicals for the control of this pest lead to various environmental concerns. Botanical insecticides have long been touted as an attractive alternative strategy for pest management because botanicals reputedly pose little threat to the environment or to human health. The commonly available weeds such as, *Ageratum houstonianum, Allamanda catharitica, Bidens pilosa, Casuarina equisetifolia, Conyza bonariensis, Crassocephalum crepidioides, Gliricidia sepium, Lantana camara, Ocimum basilicum* and *Tithonia diversifoila* found in tea plantations were collected and evaluated for their efficacy against RSM under laboratory condition. The extracts were evaluated for adulticide and ovicidal activity at two different concentrations viz., 2.5 and 5.0%. Among the plants, the aqueous extracts of *A.catharitica* and *C. bonariensis* showed 100.0 % and 80.0 % adult mortality respectively at 5% concentration after 96 h of observation. The remaining plants show moderate effect on RSM. Ovicidal activity was less pronounced among the plant extracts.

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Key words: Red spider mite, adulticidal, ovicidal, plant extracts.

INTRODUCTION

Red spider mite (RSM), *Oligonychus coffeae* (Nietner) (Tetranychidae: Acarina) a polyphagous pest feeds on coffee, rubber, indigo, grape, cashew nut, citrus, mango, camphor, mulberry, oil palm and many other tropical plants (Jeppson et al., 1975) and considered as one of the major pest in tea. In recent years it has gained a major pest status causing considerable crop loss in south Indian tea fields. RSM normally infests the upper surface of mature leaves, feeds along the mid rib and veins and gradually spreads to the entire surface of leaf thereby changes the colour of the leaf to ruddy bronze. In severe infestation it damages the younger and older leaves and ultimately leads to defoliation and debilitation of the tea bush (Radhakrishnan, 2004). During the past one decade, the control of RSM has been achieved mainly by applying synthetic acaricides like propargite, fenpropathrin, fenpyroximate, ethion and dicofol. Extensive and repeated spraying of synthetic pesticides over a long period of time could lead to undesirable effects such as contamination of environment, destruction of natural enemies, possibility of quick development of resistance to pesticides and presence of undesirable residues in processed tea. Biopesticides are important alternatives to synthetic pesticides since they possess an array of beneficial properties including repellence, antifeedant, growth regulatory activity and toxicity to insect and mite pests.

Among the various kinds of biopesticides, the secondary metabolites from plants dominate the usage since they have limited impact on the beneficial insects and require a wide exploration. Plants are rich sources of natural substances that can be utilized in the development of environmentally safe methods for insect control. They were reported to reconfigure their metabolism and generate secondary metabolites as a defense response towards herbivore attack. Research on the active ingredients, preparation and application and environmental impact of botanical pesticides are prerequisites for sustainable agriculture. In view of it Dolul and Debnath (2010) observed antifeedant activity of methanolic extracts from the flowers of *Heliotropium indicum* against the tea mosquito bug *Helopeltis theivora*.

Weed control was one of the major problems in organic field and various works have been reported on selection of pest in its herbivory. In organic tea cultivation practice to control red spider mite, the

only biopesticide recommended so far was 5% neem kernel aqueous extract. Usage of commonly available plants as pesticide was reported by various authors. Devanand and Rani, 2008, reported on the toxicity of crude extracts of commonly available trees such as, *Momordica charantia*, *Tectona grandis* and *Madhuca indica* to larvae, *Spodoptera litura* and *Achea janata*. Hence, an attempt was made to explore the potential of weeds commonly present in and around tea plantations such as, *Ageratum houstonianum* Mill., *Bidens pilosa* L., *Lantana camara* L., *Allamanda catharitica* L., *Casuarina equisetifolia* L., *Conyza bonariensis* L., *Crassocephalum crepidioides* S. Moore., *Gliricidia sepium* Walp., *Ocimum basilicum* L. and *Tithonia diversifoila* A.Gray against RSM of tea.

MATERIALS AND METHODS

Collection of plants and extract preparation

Healthy leaves and flowers of the plants such as, floss flower (*Ageratum houstonianum* Mill.), spanish needle (*Bidens pilosa* L), wild sage (*Lantana camara* L), leaves of golden trumpet (*Allamanda catharitica* L), horse tail (*Casuarina equisetifolia* L), horse weed (*Conyza bonariensis* L), fire weed (*Crassocephalum crepidioides* S. Moore), Gliricidia (*Gliricidia sepium* Walp.), thulsi (*Ocimum basilicum* L) and flowers of wild sunflower (*Tithonia diversifoila* A.Gray) were collected during morning hours from the adjoining areas of tea plantations. Their respective plant parts were shredded, shade dried for 5 days under shade and coarsely grounded. The powdered plant material was subjected to extraction.

Preparation of aqueous extract

Aqueous extraction was carried out by infusion method. Ten percent aqueous extract of each botanical was prepared by soaking 10 g of the plant powder in 100 mL of distilled water and left to stand for 12 h, then filtered through muslin cloth. The required concentration of the extract was prepared from this filtrate.

Acaricidal test

Red spider mites collected from the tea fields of organic estate were acclimatized under lab condition at a temperature of 24 ± 2^{o}C and 70-80 % relative humidity.

The acaricidal effect of plant extracts was evaluated under laboratory condition (25 ± 2^{0}C; RH: 75%). The assay was carried out by leaf disc method (Ebeling and Pence, 1953; Siegler, 1947). Leaf discs were prepared from mature tea leaves collected from experimental farm. Five leaf discs of 2 cm diameter was prepared and placed with its ventral surface down over the wet cotton taken in a petriplate (9 cm diameter) and each disc represents a replicate. Ten laboratory cultured adult mites were released on each disc with a No.000 spotting brush and allowed to settle in the disc. Five replicates were maintained for each treatment. Observations were carried out at every 24 h interval until 96 h. Neem kernel aqueous extract (5%) and propargite @ 1.1 ml/L were used as standard. A water sprayed disc served as untreated control. Adult mortality in treated discs was corrected with the control using Abbott's formula (Abbott, 1925).

Ovicidal test

To determine the ovicidal effect of the plant extracts against *O. coffeae*, adult mites (10 in number) were transferred onto each leaf disc for laying eggs. For each treatment, five replicates were maintained. After 24 h the adult mites were removed and the total numbers of eggs laid were counted. The plant extracts were sprayed over the eggs using a glass atomizer. A water sprayed leaf disc served as control. The observation was carried out for 8 days for adult emergence.

Statistical analysis of data

The results obtained were statistically analysed by completely randomized, one-way ANOVA and the posthoc test was performed by adopting Turkey HSD method in XLSTAT software package.

RESULTS AND DISCUSSION

The extracts of common weeds present in tea plantations evaluated against *O. coffeae*, under laboratory condition showed a varied response on their insecticidal activity. Their results are presented and discussed below.

Acaricidal test

The acaricidal activity of weeds was tested against adults of *O. coffeae* by leaf disc method. The extracts showed significant effect on the mortality

of RSM. Among the plants the aqueous extracts of *A. catharitica* and *C. bonariensis* showed significant adult mortality of 100.0 % and 80.0 % respectively at 5% concentration at 96 h of observation followed by *G. sepium* (70%) and flowers of *B.pilosa* (62%). The dose dependent effect of various plant extracts was shown in Table 1. The remaining plants showed less effect on the survival of RSM, while, neem kernel extract used as control showed 86 % mortality at recommended dosage of 5 % and propargite showed 100 % mortality after 24 h of observation. Similarly Miah *et al*., (2010) observed 60 % control of early shoot borer in sugarcane by spraying aqueous extract of *A.catharitica* at 20:1 concentration. Pavela (2009) reported 100 % mortality while using pongam oil against *Tetranychus urticae* at 1% and 3% concentrations. The antimicrobial and phytotoxic properties of *C. bonariensis* were reported by Shah *et al*., (2013).

The essential oils of *Lantana camara* show 100 % adult mortality against *Culex quinquefasciatus* at 400 ppm of essential oils (Dua *et al.,* 2010). Attia *et al.,* (2011) reported that garlic juice at a concentration of 7.49 and 13.5 mg/l showed LD_{50} and LD_{90} values respectively against *Tetranychus urticae* Koch. Ainge and Lorimer (2002) isolated the alkaloid huperzine A from *Lycopodium varium* as a major antifeedant and insecticidal component and showed mortality in carpet beetle, *Anthrenocerus australis* at 110 ppm. El-Kamali (2009) reported antifeedant and repellent activity against the stored pest *Tribolium castaneum* using *Bidens pilosa.*

Table 1. Effect of plant extracts on mortality of red spider mite, *O. coffeae.*

Treatments	**Mortality after 96 hrs(%)**	
	2.5%	**5.0 %**
Ageratum houstonianum Leaves	18.0 ± 0.8 c	54.0 ± 0.4ef
A.haustonianum flowers	16.0± 0.56 c	40.0 ± 0.56 gh
Allamanda catharitica	46.0 ± 2.4 a	100.00 ± 0.0 a
Bidens pilosa Leaves	16.0 ± 0.8 c	32.0 ± 0.6 gh
B.pilosa flowers	30.0 ± 1.2 c	62.0 ± 0.4 de
Casuarina equisetifolia	10.0 ± 0.4 cd	16.0 ± 1.4i
Crassocephalum crepidioides	0.0 d	0.0j
Conyza bonariensis	34.0 ± 0.4 b	80.0 ± 0.22bc
Gliricidia sepium	30.0 ± 2.4 b	70.0 ± 2.0cd
Lantana camara leaves	18.0 ± 0.2 c	30.0 ± 0.12h
L.camara flowers	14.4 ± 0.16 c	40.0 ± 0.56gh
Ocimum basilicum	12.0 ± 0.13 c	40.0 ± 0.2gh
Tithonia diversifolia flowers	16.0 ± 0.54 c	44.0 ± 4.2fg
Neem Kernel (Positive control)	54.0± 1.2 a	86.0 ±2.4b
Water – Control	0.0 d	0.0j
Propargite @1.1 ml//L showed 100.0± 0.0 % mortality observed after 24 hrs		
*Values are mentioned in Mean ± S.E. Mean followed by same alphabets are not differ significantly according to Turkey HSD test ($p<0.05$)		

Savithramma *et al*., 2013 observed the presence of saponins in aqueous extracts of *A. catharitica*. They are reported as a mild detergent possessing insecticidal property. Generally tannins are present at higher ratio in *C.ambigua* (Zamin Shah *et al.,* 2013). Tannins are also reported as a causative agent for cytotoxic effect (Aguinaldo *et al.,* 2005). Usha Rani and Pratyusha (2014) observed phenolic compounds showed considerable impact on feeding of

Achaea janata and *Spodoptera litura* and their toxic nature towards the herbivores were determined by estimating three detoxification mid-gut enzymes, glutathione-s-transferase, carboxyl esterase and β-glucosidase. These findings are in agreement with the studies of Markham *et al*., (2006) on the usage of plants rich in saponins such as ebony spleenwort (*Asplenium platyneuron*), sensitive fern (*Onoclea sensibilis*), glade fern (*Anthyrium pycnocarpon*), and the burned ground moss (*Ceratodon purpureus*), caused a greatest decrease in the larval growth of corn earworm, *Helicoverpa zea* and fall armyworm, *Spodoptera frugiperda*. The inhibitory effects of naturally occurring plant polyphenols such as tannic acid, ellagic acid, ferulic acid, caffeic acid, stilbene, quercetin, curcumin and chlorogenic acid against glutathione transferase have long been reported by many researchers (Coruh *et al*., 2007; Kawabata *et al.,* 2000).

Ovicidal test

In the present study the aqueous extracts of *C. bonariensis, A. catharitica, G. sepium* and *T. diversifolia* cause only 20 % significant reduction in adult emergence on compared to control (Table 2) and on par with propargite and neem kernel aqueous extract. While the remaining plants doesn't exhibit any inhibition on adult emergence.

Table 2. Ovicidal activity of plant extracts against red spider mite *O. coffeae*.

Plants	**Adult emergence (%)**	
	2.5 %	**5.0%**
Ageratum houstonianum leaves	100.0± 0.0	100.0± 0.0 a
A.houstonianum flower	100.0± 0.0	100.0± 0.0 a
Allamanda catharitica	100.0± 0.0	80.0 ± 2.0 b
Bidens pilosa leaves	100.0± 0.0	100.0± 0.0 a
B.pilosa flower	100.0± 0.0	100.0± 0.0 a
Casuarina equisetifolia	100.0± 0.0	100.0± 0.0 a
Crassocephalum crepidioides	100.0± 0.0	100.0± 0.0 a
Conyza bonariensis	100.0± 0.0	84.8 ± 2.82 b
Gliricidia sepium	100.0± 0.0	78.8 ± 1.6 b
Lantana camara leaves	100.0± 0.0	100.0± 0.0 a
L. camara flowers	100.0± 0.0	100.0± 0.0 a
Ocimum basilicum	100.0± 0.0	100.0± 0.0 a
Tithonia diversifolia	100.0± 0.0	80.0 ± 2.0 b
Neem kernel	100.0± 0.0	74.8 ± 1.8 b
Control	100.0± 0.0	100.0± 0.0 a
Propargite @1.1 ml/L showed 80.0 ± 2.6 %		
*Values are mentioned in Mean ± S.E. Mean followed by same alphabets are not differ significantly according to Turkey HSD test ($p<0.05$)		

Hence the plants have the property to kill adults by their contact action but they can't able to penetrate the chorion layer of eggs. While, Abdelgaleil and Badawy (2006) reported essential oils of *Lantana camara* at a concentration of 272.27 µg / mL exhibited ovicidal activity against the eggs of two-spotted spider mite *Tetranychus urticae.* The extracts of *T. diversifolia* plant analyzed by García and Delgado (2006) reported that Tagitinin A, Tagitinin C and 2α-hydroxytirotundin are the principal constituents and possess cytotoxic activity. Hence, among the screened plants only *C. bonariensis* and *A. catharitica* showed better efficacy against RSM than the neem kernel extract. Moreover, *C. bonariensis* is a potent weed and also characterized as glyphosphate resistant weed (Ge *et al*., 2010). Since there is a need for a better and environmentally safe insecticide, usage of weeds as

a pesticide can be a better remedy due to their abundance and satisfy the weed removal problems in organic tea cultivation. Further studies are under progress for testing their efficacy in field condition and analysis of active principle responsible for its intrinsic activity. The findings provide a feasible and valuable basis for further investigation.

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