Efficacy of plant extracts against *Tetranychus urticae* under *in-vitro* conditions

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**ABSTRACT:** The acaricidal activity of aqueous extracts of 20 plant species at 10 per cent concentration was evaluated against red spider mite, *Tetranychus urticae* Koch under laboratory condition by the leaf disc method. Among the plants, the extract of *Solanum virginianum* and *Eucalyptus deglupta* caused the highest mortality of 93.33 and 85.57 43 percent of *T. urticae* respectively at 72 hours after treatment (HAT) followed by *Strychnos nux-vomica* (82.23%), *Colacasia esculenta* (81.10%) and *Cymopogon schaenanthus* (81.10%). Next in the order of efficacy were *Cucumis longa*, *Dodonia viscosa*, *Melia azedarach*, *Piper nigrum*, *Phyllanthus niruri*, *Cyprus rotundus*, *Azadirachta indica*, *Cynodon dactylon* and *Andropogon murtigatus* which caused statistically similar acaricidal activity ranging from 72.23 to 64.43 percent Moderate acaricidal action was noticed in *Cardiospermum halicacabum* (56.67%) and *Antigonon leptopus* (51.10%). The least effective plants were *Spathodea campanulata* (45.57%), *Murraya koenigii* (42.23%) > *Lantana camera* (30.00%), *Pedalia murex* (30.00%) and *Ocimum tenuiflorum* (27.77%).

**Keywords:** Red spider mite, *Tetranychus urticae*, aqueous extract, acaricidal activity

**INTRODUCTION**

Two-spotted spider mite (TSSM), *Tetranychus urticae* Koch (Acarina: Tetranychidae) is a cosmopolitan herbivorous pest of agricultural crops worldwide (Antonious et al., 2007) as it infests more than thousand host plants in both field and greenhouse (Migeon and Dorkeld, 2007), especially herbaceous annuals, including beans, fruit trees and ornamental plants (Lee et al., 2003). This mite feeds by penetrating the cells of the leaf with its stylet and sucking out the cell contents that causes cell collapse and manifests as spotting on the upper leaf surface. Heavy infestations of this mite disturb the water balance in leaf and accelerate transpiration resulting in hyper-necrosis, leaf drying and leaf drop (Landeros et al., 2004). Finally, the yield is decreased while the quality is also lower or unacceptable for the market.

To combat these problems, pesticides under different groups, i.e. organochlorines, organophosphates, pyrethroids, carbamates and some unclassified group have been used against these pests. Different groups of pesticides such as sulphur, ethion, quinalphos, propargite, abamectin, dimehtaote, fenvalerate, fenpropathrin, fenazaquin, bifenthrin, hexythiazox, spiromesifen and fenpyroximate, etc. are being used as the commonly used miticides for the control of red spider mite (Mamun et al. 2014). However, overzealous use of synthetic pesticides led to numerous problems unforeseen at the time of their introduction: acute and chronic poisoning of applicators, farm workers, and even consumers; destruction of fish, birds, and other wildlife; disruption of natural biological control and pollination; extensive groundwater contamination, potentially threatening human and environmental health.

Due to those negative effects, a botanical pesticide can be employed as an alternative source to control pests where there are concerns of biodegradability, contamination in environment and human health hazards (Grange and Ahmed, 1988; Devlin and Zettel, 1999). Plants contain a rich source of bioactive chemicals which show some biological activities to specific target pests. Many plant extracts are known to be acaricidal on *T. urticae* (Shi et al., 2006). Extracts from the subfamilies Ajugoideae, Scutellarioideae, Chloanthoideae, Viticoideae and Nepetoideae have acaricidal activity (Rasikari et al., 2005).

Many workers (Yang and Tangs, 1988; Mmbone et al., 2014; Kumaran et al., 2007 and Kannianmal and Chinniah (2012) have identified the acaricidal properties of plant products against *T. urticae*. For example, the extracts of *Azadirachta indica* indica effective against *Oligonychus coffeea* (Al-Mamun et al., 2015); *Cyurban rotundus* was effective against eriophyid mite, *Aceria guerreronis* (Bhat and Kempraj, 2014); *Melia azedarach*, *Eucalyptus* sp. Effective against stored grain mite, *Rhizoglyphus tiriciti* (Bashir et al., 2013).
The objective of the present study was to investigate the acaricidal activity of selected plant extracts against *T. urticae* under laboratory conditions. In this respect, we compared the activities of extracts of seventeen plant species belonging to the families Araceae, Bignoniaceae, Cyperaceae, Lamiaceae, Loganiaceae, Meliaceae, Myrtaceae, Pedaliaceae, Phyllanthaceae, Piperaceae, Poaceae, Polygonaceae, Rutaceae, Sapindaceae, Solanaceae, Verbenaceae, Zingiberaceae. The information from these studies not only provides an insight on bioacaricidal properties of the selected bioefficacy against spider mites.

### Table 1. List of botanicals evaluated for acaricidal activities against red spider mite, *T. urticae*.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Family</th>
<th>Plant parts used</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant-ear</td>
<td>Colocasia esculenta L.</td>
<td>Araceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Fountain tree</td>
<td>Spathodea campanulata P. Beauv</td>
<td>Bignoniaceae</td>
<td>Flower</td>
<td>10%</td>
</tr>
<tr>
<td>Cyperus grass</td>
<td>Cyperus rotundus L.</td>
<td>Cyperaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Holy Basil</td>
<td>Ocimum tenuiflorum (L.) Heynh.</td>
<td>Lamiaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Strychnine</td>
<td>Strychnos nux-vomica L.</td>
<td>Loganiaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Neem</td>
<td>Azadirachta indica A. Juss.</td>
<td>Meliaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Chinaberry</td>
<td>Melia azedarach L.</td>
<td>Meliaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>Eucalyptus deglupta Blume</td>
<td>Myrtaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Large caltrops</td>
<td>Pedalium murex L.</td>
<td>Pedaliaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Keezha Nelli</td>
<td>Phyllanthus niruri L.</td>
<td>Phyllanthaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Black pepper</td>
<td>Piper nigrum L.</td>
<td>Piperaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Beard grass</td>
<td>Andropogon muricatus L.</td>
<td>Poaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Lemon grass</td>
<td>Cymbopogon schoenanthus (L.) Urban</td>
<td>Poaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Bermuda grass</td>
<td>Cynodon dactylon L.</td>
<td>Poaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Mexican creeper</td>
<td>Antigonon leptopus Hook &amp; Arn</td>
<td>Polygonaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Curry leaf</td>
<td>Murraya koenigii L.</td>
<td>Rutaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Balloon plant</td>
<td>Cardiospermum halicacabum L.</td>
<td>Sapindaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>hopbush</td>
<td>Dodonia viscosa Jacq.</td>
<td>Sapindaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Yellow-fruits nightshade</td>
<td>Solanum virginianum L.</td>
<td>Solanaceae</td>
<td>Fruit</td>
<td>10%</td>
</tr>
<tr>
<td>Lantana</td>
<td>Lantana camara L.</td>
<td>Verbenaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
<tr>
<td>Turmeric</td>
<td>Curcuma longa L.</td>
<td>Zingiberaceae</td>
<td>Leaves</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Mass culturing of two spotted spider mite *T. urticae* Koch. in screen house condition**

The Okra, *Abelmoschus esculentus* (L.) plants were raised in earthen pots for culturing mites as per the methodology suggested by Sreenivasulu (1979). These potted plants were kept separately under green house conditions at (25 ± 5°C, 60 % ± 10% RH), so as to avoid infestation from outside sources. The plants were allowed to grow and at the age of 40 days (okra), the field collected population of two spotted spider mites, *T. urticae* was released over the host plant by stapling the infested leaves over the fresh potted plant leaves, to facilitate easy transformation, after confirming the identity of the species. The two spotted spider mite, *T. urticae* from infested okra were transferred to the potted plants and allowed for multiplication for further studies.
Collection of plant species

Healthy leaves of the twenty plants (Table 1) have been collected during morning hours from the orchard, botanical garden and adjoining area of Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The plant parts were shade dried for 5 days and coarsely ground by using Willy mills and passed through 20 mesh sieve and kept in an airtight container and subjected to extraction using distilled water.

Preparation of aqueous extract

Aqueous extraction was carried out by infusion method. Ten per cent aqueous extract of each botanical was prepared by soaking 10g of the plant powder in 100ml of distilled water and left to stand for 12h, then filtered through muslin cloth. Then the filtrates were used for conducting bioassay. All the extracts were (treatment and untreated control) mixed with teepol at the rate of 1ml/lit. to facilitate adherence of the extracts to the plant surface

Effect of the extracts of botanicals on T. urticae

The acaricidal effect of plant extracts was evaluated under laboratory condition (25 ± 2°C; RH 75%). The assay was carried out by leaf disc method (Stiegl, 1947). Leaf discs were prepared from matured mulberry leaves collected from insectary at Tamil Nadu Agricultural University. Leaf discs of 6cm diameter was prepared and placed with its ventral surface down over the wet cotton taken in a petriplate (9cm diameter) and each disc represents a replicate. Thirty adult mites were released on each disc with a brush and allowed to settle in the disc. Three replicates were maintained for each treatment and a water dipped disc served as untreated control. Individual petridish was examined under a stereo binocular after 24, 48 and 72 hours of treatment for counting the live and dead mites. The adult mortality at different intervals was subjected to ANOVA to infer about the difference among the treatments at p<0.05 for variance, Least Significant Difference. Adult mortality rate was calculated as; Mortality = (Dead mites/ Total number of mites) X 100.

RESULTS

Aqueous extracts of S. virginianum and E. deglupta at 10% were significantly superior to all other treatments with the highest per cent mortality (62.23 and 57.77%) at 24 HAT (Table 2). Followed by C. esculenta (46.67%), C. longa (45.57%) and D. viscosa (43.33%) which were statistically on par in their efficacy. The sixth best treatment was S. nux-vomica at 10% which caused 34.47 per cent mortality and it was on par with M. azedarach and C. rotundus. At 48 HAT, S. virginianum and E. deglupta was found to be the most effective treatment with 81.10 per cent and 78.90 per cent mortality, which was significantly different from all other treatments. The next best treatment was S. nux-vomica (65.57%), C. esculenta (62.23%), D. viscosa (61.10%), C. longa (60.00%), C. schoenanthus (58.90%), P. niruri (57.77%) were statistically on par with each other of their efficacy. S. campanulata exhibited 50.00% mortality, which was statistically on par with P. nigrum.

Similar trend was observed at 72HAT, S. virginianum and E. deglupta was found to be the superior in acaricidal action on T. urticae with highest mortality (93.33% and 85.57%) at 10 per cent concentration and it was statistically different from all other treatments and also on par with each other in terms of efficacy. Next to E. deglupta, aqueous extracts of S. nux-vomica (82.23%), C. esculenta (81.10%) and C. schoenanthus (81.10%) were statistically on par in their acaricidal activity. C. longa, D. viscosa, M. azedarach, P. nigrum, S. campanulata, P. niruri, C. rotundus and C. dactylon registered 72.23, 67.77, 67.77, 66.67, 66.67, 65.57, 65.57 and 64.43 per cent mortality respectively and these eight treatments were statistically on par with each other but significantly differ from all other treatments. Besides the above mentioned plant extracts, A. muricatus, C. halicacabum, A. leptopus extracts also exhibited pronounced acaricidal action (61.10% to 51.10%) at 72 HAT. Moderate acaricidal action was noticed in M. koenigii (42.23%>) L. camera (30.00%)> P. mures (30.00%)> O. tenuiflorum (27.77%). All the plant extracts taken for this study did not showed any phytotoxic symptoms.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cumulative per cent mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24 h</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>46.67</td>
</tr>
<tr>
<td>(43.08)</td>
<td>(52.15)</td>
</tr>
<tr>
<td>Spathodea campanulata</td>
<td>30.00</td>
</tr>
<tr>
<td>(33.17)</td>
<td>(45.01)</td>
</tr>
<tr>
<td>Cyperus rotundus</td>
<td>32.23</td>
</tr>
<tr>
<td>(34.57)</td>
<td>(41.16)</td>
</tr>
<tr>
<td>Ocimum tenuiflorum</td>
<td>18.90</td>
</tr>
<tr>
<td>(25.73)</td>
<td>(26.53)</td>
</tr>
</tbody>
</table>
Strychnos mowonica 34.47 65.57 82.23
(35.94)\(^a\) (54.11)\(^b\) (65.30)\(^c\)
22.23 37.77 64.43
Azadirachta indica (28.12)\(^e\) (37.91)\(^fr\) (53.43)\(^s\)
33.33 45.57 67.77
Melia azedarach (35.24)\(^sde\) (42.45)\(^sde\) (55.54)\(^sde\)
57.77 78.90 85.57
Eucalyptus deglupta (49.53)\(^f\) (63.59)\(^f\) (71.02)\(^f\)
15.57 22.23 30.00
Pedalium murex (23.22)\(^s\) (28.11)\(^s\) (33.19)\(^s\)
38.90 57.77 65.57
Phylanthus niruri (38.55)\(^sc\) (49.50)\(^sc\) (54.18)\(^sc\)
43.33 50.00 66.67
Piper nigrum (41.16)\(^bc\) (45.00)\(^bc\) (54.78)\(^bc\)
8.90 43.33 61.10
Andropogon muricatus (17.35)\(^b\) (41.16)\(^p\) (51.44)\(^r\)
17.77 58.90 81.10
Cymbopogon schoenanthus (24.90)\(^sc\) (50.17)\(^sc\) (64.87)\(^sc\)
8.90 41.10 64.43
Cynodon dactylon (17.32)\(^b\) (39.85)\(^p\) (53.55)\(^p\)
21.10 35.57 51.10
Antigonon leptopus (27.33)\(^c\) (36.59)\(^c\) (45.63)\(^c\)
22.23 33.33 42.23
Murraya koenigii (28.09)\(^c\) (35.23)\(^c\) (40.51)\(^c\)
23.33 43.33 56.67
Cardiospermum halicacabum (28.87)\(^c\) (41.16)\(^p\) (48.84)\(^p\)
43.33 61.10 67.77
Dodonica viscosa (41.16)\(^bc\) (51.44)\(^bc\) (55.47)\(^bc\)
62.23 81.10 93.33
Solanum virginianum (52.15)\(^s\) (64.87)\(^s\) (75.54)\(^s\)
3.33 10.00 30.00
Lantana camara (10.50)\(^i\) (18.40)\(^i\) (33.17)\(^i\)
45.57 60.00 72.23
Curcuma longa (42.45)\(^bc\) (50.80)\(^bc\) (58.32)\(^d\)
3.33 5.83 9.73
Untreated check (Water+ Teepol) (10.50)\(^i\) (13.95)\(^h\) (18.14)\(^i\)

SE 2.03 3.29 3.74
CD (p = 0.05) 4.08 6.22 7.53
CV\% 7.92 9.53 8.95

Each value is mean of three replications.

Figures in parentheses are arc sine transformed values.

In a column, means followed by common letter (s) do not significantly differ by LSD at P=0.05%.

**DISCUSSION**

In the present study among the twenty one botanical extracts tested, the maximum mortality (93.33%) was recorded in aqueous extract of *S. virginianum* fruits. This is the first report on the acaricidal effect of *S. virginianum* on *T. urticae*. Though, the phytochemicals in *S. virginianum* (Syn: *S. xanthocarpum*) had been reported to be responsible for various pharmacological actions like Antifertility activity, Anticancer activity, Antifungal, Molluscicidal, Anti allergy, Anti inflammatory activity (Singh and Singh, 2010), the acaricidal activity has not been reported yet.

The acaricidal action of aqueous extracts of *S. virginianum* might be due to the biochemical compounds viz., Estra-1,3,5 (10)-tri-en-17-ol; Aspidospermidin-17-ol; 1-acetyl-19,21-epoxy-15,16-dimethoxy; L-(+)-Ascorbic acid 2,6-dihexadecanoate; L-Mannopynoside; Methyl 6-deoxy-2,4-di-o-methyl-acetate; Cholestern-3,ol-2-methylene; Pyrrodtine-2-ylene, thioetac acid; N,N-Dibeylidene-3, 3'-dichlorobenzidine; 16-Allopregnen,3a,7a,11a-triol-20-one, triacetate; Ascorbic acid 2; 6-dihexadecanoate, furanone, dihydro-5-tetradecyl; Furanone, dihydro-5-tetradecyl; Pyrimidin-2-ol-4(3,4-dimethoxy phynyl) 6-phynyl; 2-cyclohexen-1-one,3-methoxy-2(4,5-trimethoxyphynyl). Among the twelve compounds present in *S. virginianum*, the compounds like 6-dihexadecanote (Antonious et al., 2007 and Wang et al., 2009), Furanone (Habashy et al., 2016) have been reported to exhibit acaricidal activity. However the acaricidal action could be attributed due to the L-(+)- Ascorbic acid 2,6-dihexadecanoate (652.94 gm/mol) which had identified as a major compound.

Next to *S. virginianum*, *E. deglupta* (10%) caused (85.57%) mortality. The result could be corroborated with the findings of Idrees et al. (2016). Either extract of *Eucalyptus* sp. at 8 per cent concentration resulted more than 80% mortality after 3 weeks after spraying. The result pertaining to *C. longa*, *C. citrates, M. azedarch, P. nigrum, A. indica* are in conformity with the earlier work done by Arutselvi et al. (2013), Hanifah et al. (2011),
CONCLUSION

The botanicals used in this experiment had acaricidal action on red spider mite. Aqueous extracts of S. virginianum showed highest acaricidal action on T. urticae, followed by E. deglupta, S. max-vomica, C. esculenta and C. schoenanthus. Further study is needed to identify the active compounds of these plant extracts responsible for their acaricidal action. Plants mentioned above are abundant in and around garden lands which could be effectively utilized in Integrated Mite Management Program for sustainable crop protection in horticultural eco-system.

REFERENCES


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