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# Acaricidal activity of plant extracts on two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae)

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**Abstract**
The acaricidal activity of aqueous extract of 20 plant species at 10 percent concentration on red spider mite, *Tetranychus urticae* Koch was evaluated under laboratory condition by using the leaf disc method. Among the plants, the aqueous extract of *Sesbania grandiflora* caused highest mortality of 94.43 percent of *T. urticae* at 72 hours after treatment (HAT) which was statistically superior to all other treatments. Next to *S. grandiflora*, *Tagetes tenuifolia* (85.57%), *Artemisia pallens* (78.90%), *Cantharanthus roseus* (77.77%), *Delonix regia* (76.67%), *Cassia alata* (74.43%), *Tephrosia purpurea* (74.43%) and *Centella asiatica* (74.43%) exhibited statistically similar acaricidal activity on *T. urticae*. Further, the aqueous extract of *Jatropha curcas*, *Leucaena leucocephala*, *Senna auriculata*, *Cassia fistula* and *Anacardium occidentale* caused more than 50 percent mortality of *T. urticae.* Moderate acaricidal action was noticed in *S. aspera* (46.67%)> *A. paniculata* (42.23%)> *A. squamosa* (40.00%)> *T. procumbans* (36.67%)> *A. cantharitica* (35.57%).

**Keywords:** Red spider mite, *Tetranychus urticae*, plant extracts, acaricidal activity

## 1. Introduction
Okra, *Abelmoschus esculentus* L. (Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. In India, okra cultivated in an area of 0.51 million hectares of the area with an annual production of 5.89 million tons [1]. Edible portion of okra also provides an important source of vitamins, calcium, potassium and other mineral matters which are often lacking in the diet in developing countries [4].

In India, okra crop is cultivated in very large area but one of the major constraints for the low productivity of okra is that the crop is more vulnerable to the attack of insect pest. As high as 72 species of insects have been recorded on okra [20] of which, the sucking pests comprising of aphids, leafhopper and whitefly causes significant damage to the crop. Besides insect pests, this crop is infested mainly by six different mite pest species, *viz*., *Tetranychus urticae*, *T. macfarlanei*, *T. ludeni*, *Brevipalpus phoenicis*, *Polyphagotarsonemus latus* and *Aceria lycopersici* [16]. Out of these mite species, *T. urticae* is responsible for causing the loss of foliage of the crop plant resulting in reduction of the economic yield of fruits ranging from 20-45% depending upon cropping season and agro-climatic conditions. *T. urticae* causes damage in terms of loss of chlorophyll, stunting of growth, stippling, webbing, leaf yellowing, defoliation, leaf burning, Reduction in size and quality of fruits, appearance of various types of plant deformities, followed by death of plants [11].

Systemic and contact acaricides have been recommended for the management of bhendi red spider mite, *T. urticae.* However, frequent use of acaricides not only increases the cost of production but also result in development of resistance and resurgence of the mite species. There is an increasing interest for natural pesticides which are derived from plants [9], because they are generally perceived to be safer than the synthetics. These concerns have resulted in a renewed interest in search for alternative control measures. Many workers [23, 12, 11, 10] have identified the acaricidal properties of plant products against *T. urticae.* For example, the extracts of *Gliricidia sepium* leaves caused 100 percent mortality of *T. cinnabarinus* [19], *Tagetes minuta* and *Tephrosia vogelii* both were found to be effective against *T. urticae* [12], *Cassia alata* effective against *T. neocaledonicus* [17], *Allamanta catharitica* resulted 100 percent mortality in *Oligonychus coffeae* [16] and *Cassia fistula* shown more than 90 percent mortality of storage grain mites, *Rhizoglyphus tritici* [8].

In the present study, aqueous extract of 20 plant species belonging to Acanthaceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apiaceae, Apocynaceae, Astraceae, Euphorbiaceae and Fabaceae had been evaluated for the acaricidal activity on *T. urticae*.

## 2. Materials and Methods

This laboratory experiments was done in February 2017 at the Acarology Laboratory, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, to test various botanical extracts for their bioefficacy against spider mites.

### 2.1. 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) [20]. 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.

### 2.2. 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.

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

| Common name | Scientific name | Family | Plant parts used | Concentration |
|---|---|---|---|---|
| King of bitter | *Andrographis paniculata* L. | Acanthaceae | Leaves | 10% |
| Devil's horsewhip | *Achyranthes aspera* L. | Amaranthaceae | Leaves | 10% |
| Cashew | *Anacardium occidentale* L. | Anacardiaceae | Leaves | 10% |
| Sugar apple | *Annona squamosa* L. | Annonaceae | Leaves | 10% |
| Vallarai | *Centella asiatica* | Apiaceae | Leaves | 10% |
| Golden trumpet | *Allamanda catharitica* L. | Apocynaceae | Leaves | 10% |
| Rosy periwinkle | *Catharanthus roseus* (L.) G. Don | Apocynaceae | Leaves | 10% |
| Davana | *Artemisia pallens* Wall. | Asteraceae | Leaves | 10% |
| Golden marigold | *Tagetes tenuifolia* Cav. | Asteraceae | Flower | 10% |
| Tridax daisy | *Tridax procumbens* L. | Asteraceae | Leaves | 10% |
| Jatropha | *Jatropha curcas* L. | Euphorbiaceae | Leaves | 10% |
| Castor | *Ricinus communis* L. | Euphorbiaceae | Leaves | 10% |
| Candle bush | *Cassia alata* L. | Fabaceae | Leaves | 10% |
| Golden shower | *Cassia fistula* L. | Fabaceae | Leaves | 10% |
| Flamboyant | *Delonix regia Raf.* | Fabaceae | Leaves | 10% |
| Quick stick | *Gliricidia sepium* (Jacq.) | Fabaceae | Leaves | 10% |
| Subabul | *Leucaena leucocephala* (Lam.) | Fabaceae | Leaves | 10% |
| Senna | *Senna auriculata* L. | Fabaceae | Leaves | 10% |
| Agathi | *Sesbania grandiflora* L. | Fabaceae | Leaves | 10% |
| Tephrosia | *Tephrosia purpurea* L. | Fabaceae | Leaves | 10% |

### 2.3. Preparation of aqueous extract

Aqueous extraction was carried out by infusion method. Ten percent 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

### 2.4. 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 [18]. 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.

## 3. Results

Aqueous extract of *S. grandifolia* @ 10% was significantly superior to all other treatments with the highest percent mortality (67.77%) at 24 HAT. Followed by, *T. tenuifolia* (66.67%) and *A. pallens* (62.23%) which were statistically on par in their efficacy. The fourth best treatment was *C. asiatica* @10% which caused 60 percent mortality and it was on par with *T. tenuifolia* and *A. pallens.* In addition to the four plants mentioned above, *R. communis, C. fistula, L. leucocephala* and *J. curcas* showed as significant level acaricidal activity of 48.90, 44.43, 42.23 and 41.10 percent respectively and they were statistically on par with the each other.

At 48 HAT, *S. grandiflora* was found to be the most effective treatment with 85.20 percent mortality, which was significantly different from all other treatments. The next best treatment was *T. tenuifolia* and *C. asiatica* which caused

72.23 percent mortality, followed by *R. communis* (71.10%) and *A. pallens* (70.00%). *C. roseus* exhibited 60.00% mortality, which was statistically on par with *A. pallans*. *C. alata* (54.43%), *L. leucocephala* (53.33%), *C. fistula* (51.10%), *D. regia* (50.00%) and *J. curcas* (48.90%) were statistically on par with each other.

Similar trend was observed at 72 HAT, *S. grandiflora* was found to be the superior in acaricidal action on *T. urticae* with highest mortality (94.43%) at 10 percent concentration and it was statistically different from all other treatments. Next to *S. grandiflora*, aqueous extracts of *T. tenuifolia* (85.57%), *A. pallens* (78.90%), *C. roreus* (77.77%), *D. regia* (76.67%), *C. alata* (74.43%) and *T. purpurea* (74.43%) were statistically on par in their acaricidal activity. *J. curcas*, *L. leucocephala* and *S. auriculata* registered 67.77, 65.57 and 64.43 percent mortality respectively and these three treatments were statistically on par with each other, but significantly differ from other treatments. Besides the above mentioned plant extracts, *C. fistula*, *A. occidentale* and *G. sepium* extracts also exhibited pronounced acaricidal action (58.90% to 50.00%) at 72 HAT. Moderate acaricidal action was noticed in *S. aspera* (46.67%)> *A. paniculata* (42.23%)> *A. squamosa* (40.00%)> *T. procumbans* (36.67%)> *A. cantharitica* (35.57%).

**Table 2:** Acaricidal action of different plant species of aqueous extracts against *T. urticae* on okra.

| Treatments | Family | Cumulative percent mortality, hrs after treatment | | |
|---|---|---|---|---|
| | | 24 hrs | 48 hrs | 72 hrs |
| $T_1$- *Andrographis paniculata* | Acanthaceae | 16.67 (24.07)$^{jk}$ | 28.90 (32.49)$^{gh}$ | 42.23 (40.52)$^{ij}$ |
| $T_2$- *Achyranthes aspera* | Amaranthaceae | 16.67 (24.05)$^{jk}$ | 33.33 (35.22)$^{fgh}$ | 46.67 (43.08)$^{hij}$ |
| $T_3$-*Anacardium occidentale* | Anacardiaceae | 33.33 (35.25)$^{efg}$ | 43.33 (41.16)$^{ef}$ | 54.43 (47.55)$^{fghi}$ |
| $T_4$- *Annona squamosa* | Annonaceae | 24.43 (29.58)$^{hi}$ | 35.57 (36.57)$^{fgh}$ | 40.00 (39.20)$^{ij}$ |
| $T_5$- *Centella asiatica* | Apiaceae | 60.00 (50.79)$^{b}$ | 72.23 (58.28)$^{b}$ | 74.43 (59.72)$^{bcde}$ |
| $T_6$- *Allamanda catharitica* | Apocynaceae | 14.43 (22.32)$^{k}$ | 25.57 (30.36)$^{h}$ | 35.57 (36.60)$^{j}$ |
| $T_7$- *Catharanthus roseus* | Apocynaceae | 36.67 (37.24)$^{def}$ | 60.00 (50.82)$^{cd}$ | 77.77 (62.28)$^{bcd}$ |
| $T_8$- *Artemisia pallens* | Asteraceae | 62.23 (52.21)$^{ab}$ | 70.00 (57.10)$^{bc}$ | 78.90 (63.59)$^{bc}$ |
| $T_9$- *Tagetes tenuifolia* | Asteraceae | 66.67 (54.80)$^{ab}$ | 72.23 (58.32)$^{b}$ | 85.57 (68.26)$^{b}$ |
| $T_{10}$- *Tridax procumbens* | Asteraceae | 15.57 (23.20)$^{k}$ | 25.57 (30.33)$^{h}$ | 36.67 (37.23)$^{j}$ |
| $T_{11}$- *Jatropha curcas* | Euphorbiaceae | 41.10 (39.87)$^{cde}$ | 48.90 (44.37)$^{de}$ | 67.77 (55.45)$^{cdef}$ |
| $T_{12}$- *Ricinus communis* | Euphorbiaceae | 48.90 (44.37)$^{c}$ | 71.10 (57.57)$^{bc}$ | 85.57 (68.18)$^{b}$ |
| $T_{13}$- *Cassia alata* | Fabaceae | 22.23 (28.11)$^{ij}$ | 54.43 (47.56)$^{de}$ | 74.43 (59.90)$^{bcde}$ |
| $T_{14}$- *Cassia fistula* | Fabaceae | 44.43 (41.79)$^{cd}$ | 51.10 (45.64)$^{de}$ | 58.90 (50.21)$^{fgh}$ |
| $T_{15}$- *Delonix regia* | Fabaceae | 32.23 (34.57)$^{fg}$ | 50.00 (45.00)$^{de}$ | 76.67 (61.31)$^{bcde}$ |
| $T_{16}$- *Gliricidia sepium* | Fabaceae | 31.10 (33.86)$^{fgh}$ | 36.67 (37.23)$^{fg}$ | 50.00 (45.00)$^{ghij}$ |
| $T_{17}$- *Leucaena leucocephala* | Fabaceae | 42.23 (40.52)$^{cd}$ | 53.33 (46.92)$^{de}$ | 65.57(54.11)$^{def}$ |
| $T_{18}$- *Senna auriculata* | Fabaceae | 15.57 (23.22)$^{k}$ | 50.00 (45.00)$^{de}$ | 64.43 (53.43)$^{efg}$ |
| $T_{19}$- *Sesbania grandiflora* | Fabaceae | 67.77 (55.54)$^{a}$ | 85.20 (68.62)$^{a}$ | 94.43 (77.87)$^{a}$ |
| $T_{20}$- *Tephrosia purpurea* | Fabaceae | 26.67 (31.05)$^{ghi}$ | 43.33 (41.15)$^{ef}$ | 74.43 (65.58)$^{b}$ |
| $T_{21}$-Untreated check (Water) | - | 1.10 (6.01)$^{l}$ | 3.33 (10.51)$^{i}$ | 4.43 (12.14)$^{k}$ |
| SE | | 2.34 | 3.35 | 4.29 |
| CD(0.05) | | 4.7 | 6.76 | 8.67 |
| CV% | | 8.22 | 9.37 | 10.03 |

Each value is the mean of three replications.
Figures in parentheses are arcsine transformed values.
In a column, means followed by common letter (s) is / are not significantly different by LSD at P=0.05%.
No phytotoxic symptom was observed.

## 4. Discussion

In the present study among the twenty botanical extracts tested, the maximum mortality (94.43%) was recorded in aqueous extract of *S. grandiflora* leaves. This is the first report on the acaricidal effect of *S. grandiflora* on *T. urticae*. Though, the phytochemicals in *S. grandiflora* had been reported to be responsible for various pharmacological actions like antibacterial, antifungal, antioxidants, anti-inflammatory, anti-tumor, anti-proliferative, enzymatic activity and biological activity [26], the acaricidal activity has not been reported yet.

The acaricidal action of aqueous extract of *S. grandiflora* might be due to the one or more biochemical compounds which were identified by Zahir Hussain and Kumaresean [25], as eighteen biochemical compounds *viz.*, 3,4,5-Trimethoxyphenol(2.5%), Erucic acid(2.8%), Phtofluene(1.05%), 2-Furancarboxaldehyde (2.8%), Nonanoic acid, methyl ester (1.36%), Acrylnitrile(0.03%), 4-methyloxazole(0.06%), 1-propanol, 2-methyl(0.66%), 3-Hexene-2-one, 3,4-dimethyl (0.04%), Benzoic acid, 4-ethoxy-, ethyl ester(1.12%), 6-Octadecenoic acid, methyl ester(1.12%), 3, 5-di-t-butyl-phenol (1.12%), Urea (0.06%), Palmticacid (Hexadecanoicacid) (11.8%), 9-hexadecenol (9.0%), Dioctyl ester (10.1%), Vitamin E acetate (3.13%), Malonic acid and ethyl 3-hexyl ester in *S. grandiflora*. Among the eighteen compounds present in *S. grandiflora*, the four compounds like 2-Furancarboxaldehyde [6], Acrylonitrile [24, 7], Urea [5] and Palmtic acid (Hexadecanoicacid) [2, 22] have been reported as an acaricide earlier. However the acaricidal action could be attributed due to the Palmticacid (Hexadecanoicacid) (11.8%) which was identified as a major compound.

Next to *S. grandiflora*, *T. tenuifolia* (10%) caused 85.57 percent mortality. The result could be corroborated with other species of *Tagetes patula* which caused 85.57 percent mortality of tick, *Rhipicephalus sanguineus* at 72 hours after treatment [14] and *T. minuta* leaf extract [12] which caused 70% mortality against *T. urticae* at 24 hours after treatment.

Even though, the acaricidal activity of *A. pallens* had not been reported earlier, the present finding could be correlated with the result published reports on acaricidal action of *A. judaica* [3] and *T. vogelii* on *T. urticae*. The result pertaining to *C. alata* and *A. cantharitica* are in conformity with the earlier work done by Roy *et al.* [17] and Radhakrishnan and

Prabhakaran [16] on *T. neocaledonicus* and *Oligonychus coffeae* respectively.

## 5. Conclusion

The botanicals used in this experiment had acaricidal action on red spider mite. Aqueous extracts of *S. grandiflora* shown highest acaricidal acaricidal action on *T. urticae*. Followed by, *T. tenuifolia, A. pallans, C. roseus, D. regia* and *C. alata*. Moderate acaricidal action was noticed in *S. aspera, A. paniculata, A. squamosa, T. procumbans* and *A. cantharitica*. 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; it could be effectively utilized in integrated mite management for sustainable crop protection in olericultural eco-system.

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