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# Screening of okra, *Abelmoschus esculentus* L. (Moench) germplasm collections against two spotted spider mite, *Tetranychus urticae* (Koch) based on damage grading index

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**Abstract**
The investigation on screening forty one germplasm collections of okra for their reaction against two spotted spider mite *Tetranychus urticae* (Koch) by damage grading index and mean mite population/cm$^2$ expressed a diverse reaction among the tested entries. The results revealed that the entry *viz*., IC 117238 which recorded mean mite population of 35.6 /cm$^2$ leaf area was found to be highly susceptible to TSSM with the damage rating of four (0-4 Scale). The seven highly resistant okra germplasm collections (IC 128092, IC 128095, EC 305743, EC 306737, IC 031850, IC 105742 and IC 117235) which recorded the minimum mite population ranging between 13 and 15.67/cm$^2$ leaf area were categorized under the grade zero and could be exploited in developing a resistant source against two spotted spider mite *Tetranychus urticae.*

**Keywords**
Screening; Okra germplasm; Damage Grading Index; *Tetranychus urticae*

## INTRODUCTION

Okra (*Abelmoschus esculentus* L. (Moench) is an important vegetable crop grown in tropical Asia and sub-Saharan Africa. The production of okra is estimated to be 8.06 million tons annually in the world. India is the world's leading okra producer (72 % of total production) (FAO, 2011).The estimated loss in the yield of okra fruits due to *T. urticae* damage ranged from 7 - 48 per cent. *T. urticae* caused 17 - 46 per cent yield loss in okra during 1991-92 (Hussey and Parr, 1963). The injury and the resultant yield loss due to mite is related to many variables like the intensity of attack, weather conditions, the species of mite, the crop species and even the variety etc. (Van de Vrie *et al*., 1972). Plant resistance to the pest attack can be caused by antixenosis, antibiosis, tolerance, or sum combinations of these mechanisms (Painter 1951; Kogan and Ortman 1978). Host plants have main effects on development, mortality and fecundity rates of mites. Therefore, Knowledge of cultivar susceptibility or resistance might be a fundamental component of an integrated pest management program (IPM) for any crop (Narayanan. and Muthiah, 2017). Such information can be used in developing an insect resistant cultivar (Jyoti *et al*., 2001) or designing and good assays for breeding new varieties (Stoner and Shelton, 1988).

The intention of this study was to screen certain germplasm collections of okra and local popular varieties for their reaction against two spotted spider mite *Tetranychus urticae* (Koch) in screen house condition.

## MATERIALS AND METHODS

Okra germplasms including local popular varieties, landraces, hybrids and cultivars were collected from farmers, seed venders, National Bureau of Plant Genetic Resources (NBPGR) and Tamil Nadu Agricultural University (TNAU). The 41 okra germplasm obtained from various sources were utilized for screening studies. Preliminary screening of all okra germplasm collections

was carried out for reaction against the infestation by two spotted spider mites. The seedlings were raised in pots and were thinned later (ten days after sowing) in order to maintain uniform population in all the pots. Mite cultures were introduced (Active forms) @ 30 mites per pot which were allowed for 10 days for proper establishment. The damage to host plants by mite feeding activity was judged on the basis of leaf spotting and loss of chlorophyll. A rating method as developed by Palanisamy *et al* (1984) was adopted to estimate the relative resistance / susceptibility of the screening materials. The test entries were evaluated / graded visually based on the injury levels exhibited on the leaves as suggested by (Palanisamy *et al*, 1984) . The grading was done on 55, 75 and 95 days after sowing both in pot culture and field experiments.

| Injury level | Category | Grade |
|---|---|---|
| Plants with no feeding injury (immune) | Highly resistant | 0 |
| Plants with slight injury – a few chlorotic spots on the leaves and a few mites on some leaves | Resistant | 1 |
| Plants showing moderately high degree of injury, mites abundant on many leaves and leaves silvered by feeding and leaf size reduced | Moderately resistance | 2 |
| Plants showing very high injury, curling of leaves and stunting of plants | Susceptible | 3 |
| Plants showing severe damage and defoliation and / or death of plants | Highly susceptible | 4 |

In the screening experiment two spotted spider mite *Tetranychus urticae* population was assessed 10 days after the inoculation and recorded at 10 days interval starting from 40 DAS to 90 DAS. Mite populations were assessed in one $cm^2$ area on top, middle and bottom leaves of each plant from each test entries, covering sufficient replications (Table 3).

The mean population data were subjected to square root transformation. The data thus obtained were subjected to Analysis of Variance (ANOVA) using the software AGRES. The significance of differences was tested by F-tests, while the significance of difference between the treatment mean values was compared by LSD at 5 per cent probability.

## RESULTS AND DISCUSSION

The screening of 41 okra germplasm collections against two spotted spider mite *T. urticae* revealed that the highest mean mite population (**Table 1**) was recorded on IC 117238 (35.67 no's/$cm^2$ leaf area) which significantly differed from other entries screened. This germplasm was also found to be highly susceptible to two spotted spider mite *T. urticae* infestation with damage rating of four (Plate 1). Of the 41 germplasm entries tested, the damage score of four was recorded with reference to the following five entries IC 014600, IC 022232, IC 034190C, IC 117238 and Indus 161 (popular hybrid) which were found to be highly susceptible (Table 2). The results were in agreement with the findings of Gulati (2004), who reported that among six cultivars of okra tested, Pusa Sawani and Varsha Uphar harboured the highest numbers of *T. cinnabarinus* population, whereas Sanjam was found to be the least susceptible to mite attack.

Among the seven highly resistant okra germplasms (IC 128092, IC 128095, EC 305743, EC 306737, IC 031850, IC 105742, IC 117235), IC 128092 recorded

**Table 2. Categorization of okra germplasm collections (by damage grading index)**

| Grade | Reaction | No. of germplasm | Accession/variety/ hybrid |
|---|---|---|---|
| **0** | **Highly resistant** | 7 | IC 128092, IC 128095, EC 305743, EC 306737, IC 031850, IC 105742, IC 117235. |
| **1** | **Resistant** | 15 | IC 043748, IC 282278 , IC 140927, EC 329421, EC 305771, IC 003307, IC 003573, IC 018532, IC 018537, IC 018540, IC 022285, IC 033854C, IC 099746, IC 117228, IC 117260. |
| **2** | **Moderately resistant** | 7 | IC 128122, IC 015435, IC 045132, IC 469666 , IC 205147, Sakthi, Red bhendi. |
| **3** | **Susceptible** | 7 | IC 034190A, IC 111514, IC 112476, IC 117308 , Arka anamika, Mahyco 10, Bhendi hybrid CO 4. |
| **4** | **Highly susceptible** | 5 | IC 014600, IC 022232, IC 034190C, IC 117238, Indus 161. |

**Table 1. Screening of okra germplasm collections (Damage grading index by Palanisamy *et al*., 1984)**

| S.NO | Okra entries | Mean damage grading index** | | | Overall mean damage index | Reaction* |
|---|---|---|---|---|---|---|
| | | 55 DAS | 75 DAS | 90 DAS | | |
| 1 | IC 043748 | 0.33 | 0.33 | 0.33 | 1.00 | **R** |
| 2 | IC 282278 | 0.33 | 1.00 | 0.00 | 1.33 | **R** |
| 3 | IC 140927 | 0.33 | 0.67 | 0.33 | 1.33 | **R** |
| 4 | IC 128092 | 0.00 | 0.33 | 0.33 | 0.67 | **HR** |
| 5 | IC 128095 | 0.00 | 0.00 | 0.33 | 0.33 | **HR** |
| 6 | IC 128122 | 0.67 | 0.67 | 1.33 | 2.67 | **MR** |
| 7 | EC 329421 | 0.33 | 0.67 | 0.67 | 1.67 | **R** |
| 8 | EC 305743 | 0.33 | 0.00 | 0.00 | 0.33 | **HR** |
| 9 | EC 305771 | 0.67 | 0.33 | 0.33 | 1.33 | **R** |
| 10 | EC 306737 | 0.33 | 0.00 | 0.33 | 0.67 | **HR** |
| 11 | IC 003307 | 0.33 | 0.33 | 0.67 | 1.33 | **R** |
| 12 | IC 003573 | 0.33 | 1.00 | 0.00 | 1.33 | **R** |
| 13 | IC 014600 | 1.33 | 1.33 | 1.33 | 4.00 | **HS** |
| 14 | IC 015435 | 0.67 | 0.67 | 1.33 | 2.67 | **MR** |
| 15 | IC 018532 | 0.33 | 0.67 | 0.33 | 1.33 | **R** |
| 16 | IC 018537 | 0.33 | 0.33 | 1.00 | 1.67 | **R** |
| 17 | IC 018540 | 0.33 | 0.00 | 1.33 | 1.67 | **R** |
| 18 | IC 022232 | 1.33 | 1.33 | 1.33 | 4.00 | **HS** |
| 19 | IC 022285 | 0.33 | 0.33 | 0.33 | 1.00 | **R** |
| 20 | IC 031850 | 0.00 | 0.00 | 0.33 | 0.33 | **HR** |
| 21 | IC 033854C | 0.67 | 0.33 | 0.33 | 1.33 | **R** |
| 22 | IC 034190A | 0.67 | 1.00 | 1.33 | 3.00 | **S** |
| 23 | IC 034190C | 1.33 | 1.33 | 1.33 | 4.00 | **HS** |
| 24 | IC 045132 | 0.67 | 1.00 | 0.67 | 2.33 | **MR** |
| 25 | IC 099746 | 0.33 | 0.33 | 1.00 | 1.67 | **R** |
| 26 | IC 105742 | 0.33 | 0.00 | 0.33 | 0.67 | **HR** |
| 27 | IC 111514 | 1.00 | 1.00 | 1.33 | 3.33 | **S** |
| 28 | IC 112476 | 0.67 | 1.00 | 1.33 | 3.00 | **S** |
| 29 | IC 117228 | 0.33 | 0.33 | 0.33 | 1.00 | **R** |
| 30 | IC 117235 | 0.33 | 0.00 | 0.00 | 0.33 | **HR** |
| 31 | IC 117238 | 1.33 | 1.33 | 1.33 | 4.00 | **HS** |
| 32 | IC 117260 | 0.33 | 0.67 | 0.67 | 1.67 | **R** |
| 33 | IC 117308 | 0.67 | 1.33 | 1.33 | 3.33 | **S** |
| 34 | IC 205147 | 1.00 | 1.00 | 0.67 | 2.67 | **MR** |
| 35 | IC 469666 | 0.67 | 0.67 | 1.33 | 2.67 | **MR** |
| 36 | Arka anamika | 1.00 | 1.33 | 1.33 | 3.67 | **S** |
| 37 | Indus 161 | 1.33 | 1.33 | 1.33 | 4.00 | **HS** |
| 38 | Red bhendi | 0.67 | 0.67 | 0.67 | 2.00 | **MR** |
| 39 | Mahyco 10 | 0.67 | 1.33 | 1.33 | 3.33 | **S** |
| 40 | Sakthi | 0.67 | 1.00 | 0.67 | 2.33 | **MR** |
| 41 | Bhendi hybrid CO 4 | 1.00 | 1.00 | 1.00 | 3.00 | **S** |

**Each value is the mean of three replications.

* 0 (0-0.9) – Highly resistant (**HR**) , * 1 (1-1.9) –Resistant (**R**)

* 2(2-2.9) – Moderately resistance (**MR**), * 3 (3-3.9) – Susceptible (**S**), * 4(4) – Highly susceptible (**HS**)

the minimum mite population of 13 /cm$^2$ leaf area which was categorized under grade zero (**Table 2**). Similar screening of okra varietal collections against two spotted spider mite *T. urticae* by damage grading index had also been reported by Sheeba *et al*. (2011), seven varieties of bhendi were screened for their tolerance to the spider mite, *T. cinnabarinus* by Ghosh *et al*. (1995) who reported that the variety GOH-3 was tolerant. Manual *et al*. (2007) also reported the reaction of seven okra lines against *T. neocaledonicus* in Pusa and revealed that the lines viz., Arka Anamika, Arka Abhay, D-1-87-5, D-1-87-16 and HRB-55 had a lower infestation while the cultivar, Pusa Sawani

showed a comparatively low infestation. Jaydeb *et al.* (1995) had also reported similar findings that the bhendi variety GOH-3 was tolerant to *T. cinnabarinus* infestation at Kalyani, West Bengal in screen house condition.

**Table 3. Population of two spotted spider mite *T. urticae* Koch on okra germplasm collections**

| S.NO | Okra entries | Mite population*/ cm² leaf area | | | Overall Mean |
|---|---|---|---|---|---|
| | | 50 DAS | 70 DAS | 90 DAS | |
| 1 | IC 043748 | 6.00 (2.44)$^{e}$ | 16.00 (4.00)$^{f}$ | 30.00 (5.47)$^{de}$ | 17.33 (4.16)$^{d}$ |
| 2 | IC 282278 | 8.00 (2.82)$^{g}$ | 19.00 (4.35)$^{i}$ | 34.00 (5.83)$^{hi}$ | 20.33 (4.51)$^{h}$ |
| 3 | IC 140927 | 6.00 (2.44)$^{e}$ | 17.00 (4.12)$^{g}$ | 31.00 (5.56)$^{ef}$ | 18.00 (4.24)$^{de}$ |
| 4 | IC 128092 | 2.00 (1.41)$^{b}$ | 11.00 (3.31)$^{a}$ | 26.00 (5.09)$^{a}$ | 13.00 (3.61)$^{a}$ |
| 5 | IC 128095 | 3.00 (1.73)$^{c}$ | 13.00 (3.60)$^{c}$ | 28.00 (5.29)$^{bc}$ | 14.67 (3.83)$^{b}$ |
| 6 | IC 128122 | 10.00 (3.16)$^{i}$ | 21.00 (4.58)$^{k}$ | 35.00 (5.91)$^{i}$ | 22.00 (4.69)$^{i}$ |
| 7 | EC 329421 | 8.00 (2.82)$^{g}$ | 19.00 (4.35)$^{i}$ | 35.00 (5.91)$^{j}$ | 20.67 (4.55)$^{h}$ |
| 8 | EC 305743 | 1.00 (1.00)$^{a}$ | 12.00 (3.46)$^{b}$ | 27.00 (5.19)$^{ab}$ | 13.33 (3.65)$^{a}$ |
| 9 | EC 305771 | 9.00 (3.00)$^{h}$ | 18.00 (4.24)$^{h}$ | 34.00 (5.83)$^{hi}$ | 20.33 (4.51)$^{h}$ |
| 10 | EC 306737 | 4.00 (2.00)$^{d}$ | 14.00 (3.74)$^{d}$ | 29.00 (5.38)$^{cd}$ | 15.67 (3.96)$^{a}$ |
| 11 | IC 003307 | 7.00 (2.64)$^{f}$ | 18.00 (4.24)$^{h}$ | 33.00 (5.74)$^{gh}$ | 19.33 (4.40)$^{g}$ |
| 12 | IC 003573 | 6.00 (2.44)$^{e}$ | 17.00 (4.12)$^{g}$ | 30.00 (5.47)$^{de}$ | 17.67 (4.20)$^{de}$ |
| 13 | IC 014600 | 20.00 (4.47)$^{s}$ | 32.00 (5.65)$^{t}$ | 45.00 (6.70)$^{o}$ | 32.33 (5.69)$^{q}$ |
| 14 | IC 015435 | 11.00 (3.31)$^{j}$ | 23.00 (4.79)$^{l}$ | 37.00 (6.08)$^{j}$ | 23.67 (4.87)$^{j}$ |
| 15 | IC 018532 | 9.00 (3.0)$^{h}$ | 19.00 (4.35)$^{i}$ | 35.00 (5.91)$^{i}$ | 21.00 (4.58)$^{h}$ |
| 16 | IC 018537 | 8.00 (2.82)$^{g}$ | 17.00 (4.12)$^{g}$ | 32.00 (5.65)$^{fg}$ | 19.00 (4.36)$^{fg}$ |
| 17 | IC 018540 | 6.00 (2.44)$^{e}$ | 16.00 (4.00)$^{f}$ | 31.00 (5.56)$^{ef}$ | 17.67 (4.20)$^{de}$ |
| 18 | IC 022232 | 21.00 (4.58)$^{t}$ | 33.00 (5.74)$^{u}$ | 42.00 (6.48)$^{m}$ | 32.00 (5.66)$^{q}$ |
| 19 | IC 022285 | 7.00 (2.64)$^{f}$ | 18.00 (4.24)$^{h}$ | 32.00 (5.65)$^{fg}$ | 19.00 (4.36)$^{fg}$ |
| 20 | IC 031850 | 4.00 (2.00)$^{d}$ | 13.00 (3.60)$^{c}$ | 29.00 (5.38)$^{cd}$ | 15.33 (3.92)$^{b}$ |
| 21 | IC 033854C | 6.00 (2.44)$^{e}$ | 17.00 (4.12)$^{g}$ | 32.00 (5.65)$^{fg}$ | 18.33 (4.28)$^{ef}$ |
| 22 | IC 034190A | 15.00 (3.87)$^{n}$ | 26.00 (5.09)$^{o}$ | 40.00 (6.32)$^{l}$ | 27.00 (5.20)$^{n}$ |
| 23 | IC 034190C | 23.00 (4.79)$^{v}$ | 34.00 (5.83)$^{uv}$ | 44.00 (6.63)$^{no}$ | 33.67 (5.80)$^{r}$ |
| 24 | IC 045132 | 12.00 (3.46)$^{k}$ | 24.00 (4.89)$^{m}$ | 38.00 (6.16)$^{jk}$ | 24.67 (4.97)$^{kl}$ |
| 25 | IC 099746 | 7.00 (2.64)$^{f}$ | 15.00 (3.87)$^{e}$ | 33.00 (5.74)$^{gh}$ | 18.33 (4.28)$^{ef}$ |
| 26 | IC 105742 | 2.00 (1.41)$^{b}$ | 12.00 (3.46)$^{b}$ | 27.00 (5.19)$^{ab}$ | 13.67 (3.70)$^{a}$ |
| 27 | IC 111514 | 16.00 (4.00)$^{o}$ | 27.00 (5.19)$^{p}$ | 42.00 (6.48)$^{m}$ | 28.33 (5.32)$^{o}$ |
| 28 | IC 112476 | 18.00 (4.24)$^{q}$ | 28.00 (5.29)$^{q}$ | 43.00 (6.55)$^{mn}$ | 29.67 (5.45)$^{p}$ |
| 29 | IC 117228 | 8.00 (2.82)$^{g}$ | 20.00 (4.47)$^{j}$ | 34.00 (5.83)$^{hi}$ | 20.67 (4.55)$^{h}$ |
| 30 | IC 117235 | 1.00 (1.00)$^{a}$ | 11.00 (3.31)$^{a}$ | 28.00 (5.29)$^{bc}$ | 13.33 (3.65)$^{a}$ |
| 31 | IC 117238 | 22.00 (4.69)$^{u}$ | 35.00 (5.91)$^{v}$ | 50.00 (7.07)$^{p}$ | 35.67 (5.97)$^{q}$ |
| 32 | IC 117260 | 9.00 (3.00)$^{h}$ | 17.00 (4.12)$^{g}$ | 35.00 (5.91)$^{i}$ | 20.33 (4.51)$^{h}$ |
| 33 | IC 117308 | 17.00 (4.12)$^{p}$ | 28.00 (5.29)$^{q}$ | 44.00 (6.63)$^{no}$ | 29.67 (5.45)$^{p}$ |
| 34 | IC 205147 | 13.00 (3.60)$^{l}$ | 24.00 (4.89)$^{m}$ | 39.00 (6.24)$^{kl}$ | 25.33 (5.03)$^{lm}$ |
| 35 | IC 469666 | 14.00 (3.74)$^{m}$ | 25.00 (5.00)$^{n}$ | 38.00 (6.16)$^{jk}$ | 25.67 (5.45)$^{m}$ |
| 36 | Arka anamika | 18.00 (4.24)$^{q}$ | 29.00 (5.38)$^{r}$ | 42.00 (6.48)$^{m}$ | 29.67 (5.45)$^{p}$ |
| 37 | Indus 161 | 27.00 (5.19)$^{w}$ | 32.00 (5.65)$^{t}$ | 44.00 (6.63)$^{no}$ | 34.33 (5.86)$^{r}$ |
| 38 | Red bhendi | 11.00 (3.31)$^{j}$ | 23.00 (4.79)$^{l}$ | 39.00 (6.24)$^{kl}$ | 24.33 (4.93)$^{jk}$ |
| 39 | Mayco 10 | 17.00 (4.12)$^{p}$ | 24.00 (4.89)$^{m}$ | 44.00 (6.63)$^{no}$ | 28.33 (5.32)$^{o}$ |
| 40 | Sakthi | 15.00 (3.87)$^{n}$ | 24.00 (4.89)$^{m}$ | 40.00 (6.32)$^{l}$ | 26.33 (5.13)$^{mn}$ |
| 41 | Co 4 Bhendi hybrid | 19.00 (4.35)$^{r}$ | 30.00 (5.47)$^{s}$ | 45.00 (6.70)$^{o}$ | 31.33 (5.60)$^{q}$ |
| | CD (p=0.05) | 0.06 | 0.08 | 0.13 | 0.09 |
| | SEd | 0.03 | 0.04 | 0.06 | 0.05 |

*Each value is the mean of three replications.
Figures in parentheses are square root transformed values.
In a column, means sharing similar letter(s) is /are not significantly different by LSD at P=0.05%.

The seven entries *viz.,* IC 128122, IC 015435, IC 045132, IC 469666, IC 205147, Sakthi and Red bhendi which recorded damage score below 3 (2 to 2.26) were categorized as moderately resistant (**Table 2**) and the mean mite population ranged from 22 to 26.33 /cm$^2$ leaf area (**Fig. 1**) (**Table 3)**he related varietal screening of okra against *Tetranychus cinnabarinus* (Boisduval) were also in agreement with the reports of Sahayaraj *et al*. (2003), whereas EC 28427, IC 141065, IC 90049 were rated as resistant and EC 329364, IC 140977, TC 90074 were rated as moderately resistant. Nain *et al*. (2017) also evaluated 25 genotypes of okra for field resistance against two spotted spider mite *T. urticae* and reported that the two for each least susceptible category (HB-02-14-1-1 and HB-02-17-1) and moderately susceptible category (HTB-1-17-5; HRB-107-4-1), and highly susceptible category (HBT-6-15-3-7;BB1).

From the preliminary screening of okra germplasm collections against *T. urticae*, the resistant (IC 128092, IC 128095, EC 305743, EC 306737, IC 031850, IC 105742, IC 117235) and susceptible (IC 014600, IC 022232, IC 034190C, IC 117238, Indus 161) okra germplasm collections identified would be tested in the field condition and incorporated in developing a resistant variety especially against *T. urticae*.

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