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## Article

### Screening of 55 pinto bean lines for resistance to the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae)

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#### ABSTRACT

Two-spotted spider mite (TSSM) (*Tetranychus urticae* Koch) is considered as the most important pest of bean in different parts of the world. In this study, 55 lines selected from different germplasms of pinto bean, were screened for resistance to the TSSM in two stages. In the first stage, they were classified into five groups based on the intensity of damage to their leaf disks (from 0, without damage to 6, feeding patches more than 80% of leaf area). Twenty-one lines presented the highest leaf damage index (LDI =  $5.30 \pm 0.27$ ), therefore, they were excluded from subsequent experiments, except line 'D<sub>521</sub>', which was used as the susceptible check. In the second stage, 34 lines with LDI less than 4, along with line 'D<sub>521</sub>' (as susceptible), were studied using leaf disk bioassay. Based on the results, line 'D<sub>521</sub>' ( $7.52 \pm 1.23$  eggs/female/day) supported the highest, whereas, lines 'L<sub>1</sub>' ( $1.46 \pm 0.23$ ), 'J<sub>29</sub>' ( $1.60 \pm 0.26$ ) and 'L<sub>19</sub>' ( $1.69 \pm 0.59$  eggs/female/day) supported the lowest level of oviposition. The highest and lowest level of damage was observed on leaf disk of 'D<sub>521</sub>' ( $5.5 \pm 0.40$ ) and 'L<sub>19</sub>' ( $1.8 \pm 0.37$ ), respectively. The studied lines were classified into five groups, based on the mite response to the host (oviposition and mortality) and host response to the mite (damage score). In the cluster analysis, lines 'D<sub>521</sub>', 'J<sub>633</sub>', 'D<sub>524</sub>' and 'D<sub>532</sub>' appeared to be highly susceptible and susceptible, whereas, lines 'L<sub>31</sub>', 'L<sub>329</sub>', 'L<sub>321</sub>', 'L<sub>16</sub>', 'B<sub>417</sub>', 'B<sub>425</sub>', 'L<sub>328</sub>', 'J<sub>29</sub>', 'J<sub>67</sub>', 'L<sub>19</sub>', 'D<sub>3</sub>', 'L<sub>25</sub>' and 'L<sub>1</sub>' were resistant to TSSM, which can be used as the source of resistance in future plant breeding programs.

**KEY WORDS:** Cluster analysis; infestation; leaf damage index; leaf disk bioassay; susceptibility.

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#### INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is one of the most important and widely grown crops in the world, cultivated commercially in many parts (e.g. Markazi, Lorestan, Chaharmahal va Bakhtiari, Fars and Zanzan provinces) of Iran (Saeidi and Salehi 2005; Modarres Njafabadi and Zamani 2013). Among different pests attacking this crop, the two-spotted spider mite (TSSM) (*Tetranychus urticae* Koch) is considered as the most important pest causing serious damage by sucking leaves' cell contents (Saeidi and Salehi 2005). During favorable conditions (hot and dry season), mite population increases rapidly, plant foliage gets covered with webbing, the leaves turn yellowish and drop off (Godfrey 2011) and the seed quantity and quality gets significantly reduced (Saeidi 2011).

Because of the short life span, high fecundity and ability of TSSM to develop resistance to many acaricides, an integrated program is essential for sustainable management of its population (Luczynski *et al.* 1990). Host-plant resistance, as an inseparable element of integrated pest management (IPM) program, is not only compatible with other methods of control (Lorenzen *et al.*

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2001), but also, in many cases, useful to enhance the efficiency of biological control agents (Bong *et al.* 1991). Use of host plant resistance is widely known as an efficient, economical, ecological and socially advantageous control method within IPM programs (Stenberg 2017).

Host plant resistance to the two-spotted spider mite has been reported in different crops such as raspberry (Wilde *et al.* 1991), strawberry (Gimenez-Ferrer *et al.* 1994), tomato (Saeidi and Mallik 2006), soybean (Sedaratian *et al.* 2009), eggplant (Khanamani *et al.* 2012), almond (Saeidi 2013), bean (Modarres Njafabadi and Zamani 2013; Mohammadi *et al.* 2013), cucumber (Mohammadi *et al.* 2015) and peach (Riahi *et al.* 2020). Different studies have been done on the biology and life table parameters of the TSSM on different bean varieties, but a few lines or varieties of pinto bean are reported as resistant to the mite. Screening techniques help us to identify resistant lines or varieties (among large number of individuals), and eliminate the majority of susceptible ones (Panda and Khush 1995). Therefore, the present study was performed to select resistant lines among different genotypes of pinto bean which can be used by the breeders in future bean breeding programs.

## MATERIAL AND METHODS

### *Plant materials*

Nine accessions from different parts of Chaharmahal va Bakhtiari province, Iran, including Lordegan (6 accessions), Boldaji, Dastgerd (Kiar) and Joneghan (one accession from each) were collected. Fifty seeds from each accession were planted in the field under natural conditions and artificially infested by introducing five adult females per plant at seedling stage (two-leaf stage). Those lines (totally 54) which survived till harvesting stage and produced vigorous seeds were selected and studied under greenhouse and laboratory conditions along with the commercial variety of “Talash” (as control). Lines which originated from Lordegan, Boldaji, Dastgerd and Joneghan accessions are shown by letters L, B, D and J, respectively.

### *Maintenance of the mite culture*

The strain of *T. urticae* used in this study originated from infested leaves of bean, *P. vulgaris*, collected from Lordegan fields. Mite rearing was carried out on ‘Talash’ variety under greenhouse conditions. The individual mites used for the experiments were collected and transferred to the plants using a fine camel hair brush.

### *Screening for resistance to the two-spotted spider mite*

Screening for resistance to the TSSM was carried out at two stages. In the first stage, 55 lines, selected from different accessions of pinto bean, were studied based on the leaf damage score. The experiment was conducted based on the completely randomized design (CRD) under greenhouse conditions ( $25 \pm 2$  °C, RH  $50 \pm 10\%$  and photoperiod 14 L: 10 D) in three replicates. Each replicate contained three pots. Plants were sown in pots (15 × 20 × 20 cm) and watered daily. They were covered by insect proof nets to avoid any contamination. Infestation of the lines was done when the plants were at two-leaf stage by introducing five adult females (3 days in age). After two weeks, five leaves of each plant were selected randomly and scored based on the intensity of damage (from 0, without damage to 6, feeding patches more than 80% of leaf area).

Leaf damage index (LDI): LDI scored on a 0 to 6 scale, based on the intensity of damage described by Nihoul *et al.* (1991), Gimenez-Ferrer *et al.* (1993) and Saeidi and Mallik (2006) as:

0 = no damage

1 = Few small feeding patches < 10 % of leaf area.

2 = Feeding patches 10–25 % of leaf area

3 = Feeding patches 26–40 % of leaf area

4 = Feeding patches 41–60 % of leaf area

- 5 = Feeding patches 61–80 % leaf area  
6 = Feeding patches 81–100 % of leaf area

### *Second stage*

Thirty-three lines (with LDI less than 5) along with line 'D<sub>521</sub>' (LDI = 5) and 'Talash' variety (as control) were studied based on the leaf disk bioassay. Plants were grown under greenhouse conditions (as described above) based on the completely randomized design in three replicates.

### *Leaf disk bioassay*

Four weeks after sowing, when the plants were at 5–6 leaf stages, two leaves from each plant (totally 6 leaves from each treatment) were collected from equivalent positions (3<sup>rd</sup> and 4<sup>th</sup> leaves from the top) and used for leaf disk bioassay. Leaf disks (2 cm diameter) were obtained from either side of the main vein and placed with abaxial surface facing up on a water-saturated none-sterile cotton wad in a plastic Petri dish (12 cm diameter). For bioassay, five adult female mites (3 days in age) were introduced on each disk and kept in an incubator (25 ± 2 °C, RH 50 ± 10% and photoperiod 14 L: 10 D). After 72 h, the number of laid eggs and number of alive mites on each disk were recorded. Moreover, LDI scored on a 0 to 6 scale after 96 h, as previously described (Gimenez-Ferrer *et al.* 1993; Saeidi and Mallik 2006).

### *Statistical analysis*

Statistical analysis was performed using SAS (version 9.1) and SPSS (version 22) software. Analysis of variance (Proc ANOVA) was performed to identify significant differences among the treatments and means compared using LSD test at 5% level. To compare non-parametric data, Kruskal-Wallis test was used. Proc Clus was performed for grouping different lines based on 1 to 6 scales. Proc Corr was used for identifying the relation between variables. Data normality was assessed using Kolmogorov–Smirnov test and, data conversion was performed using the formula  $\sqrt{x + 1}$ , if required.

## RESULTS

### *First stage*

Studied lines were classified into five groups based on the leaf damage index (Table 1). Based on the results, lines 'L<sub>19</sub>' and 'L<sub>1</sub>' showed the lowest leaf damage index (LDI = 1.2 ± 0.18). Nine lines including 'L<sub>31</sub>', 'L<sub>329</sub>', 'L<sub>321</sub>', 'L<sub>16</sub>', 'B<sub>425</sub>', 'J<sub>29</sub>', 'J<sub>67</sub>', 'D<sub>3</sub>' and 'L<sub>25</sub>' showed 10 to 25% feeding patches on their leaves (LDI = 2.5 ± 0.35). Thirteen lines exhibited 26 to 40 % (LDI = 3.70 ± 0.25), whereas 10 lines showed 41 to 60% of feeding patches on their leaf area, respectively. Twenty-one lines presented the highest LDI (feeding patches 61 to 80%), therefore, all of them, except line 'D<sub>521</sub>', were removed. Finally, 34 lines with LDI less than 4.60 ± 0.32, along with line 'D<sub>521</sub>' (as susceptible) were selected for further studies.

### *Second stage*

Selected lines were classified in different groups based on the mite oviposition, mite mortality and leaf damage index.

### *Mite oviposition and mortality*

Studied lines significantly influenced the oviposition response of TSSM females. The highest level of oviposition (number of eggs/female/day) was supported by line 'D<sub>521</sub>' (7.52 ± 1.23) followed by line 'J<sub>632</sub>' (6.72 ± 0.68), whereas, line 'L<sub>1</sub>' supported the lowest level of oviposition (1.46 ± 0.23) followed by lines 'J<sub>29</sub>' (1.60 ± 0.26) and 'L<sub>19</sub>' (1.69 ± 0.59) (Table 2). The highest

number of alive mites (out of 5 mites) were recorded on lines 'J<sub>617</sub>' (4.90 ± 0.10) and 'B<sub>432</sub>' (4.75 ± 0.20), whereas the lowest were on lines 'L<sub>329</sub>' (1.2 ± 0.2) and 'L<sub>19</sub>' (1.40 ± 0.4) (Table 2).

**Table 1.** Grouping of 55 lines of pinto bean, *Phaseolus vulgaris*, for resistance to *Tetranychus urticae* based on mean (± SE) leaf damage score.

Clusters	Leaf damage score	Lines
<b>Highly Susceptible</b>	5.30 ± 0.27	'L <sub>12</sub> ', 'L <sub>13</sub> ', 'L <sub>14</sub> ', 'L <sub>15</sub> ', 'L <sub>17</sub> ', 'L <sub>18</sub> ', 'L <sub>20</sub> ', 'L <sub>21</sub> ', 'L <sub>22</sub> ', 'L <sub>23</sub> ', 'L <sub>24</sub> ', 'L <sub>26</sub> ', 'L <sub>27</sub> ', 'L <sub>28</sub> ', 'L <sub>32</sub> ', 'L <sub>33</sub> ', 'L <sub>34</sub> ', 'L <sub>35</sub> ', 'L <sub>36</sub> ', 'L <sub>37</sub> ', 'D <sub>521</sub> '
<b>Susceptible</b>	4.60 ± 0.32	'D <sub>524</sub> ', 'D <sub>532</sub> ', 'L <sub>323</sub> ', 'J <sub>617</sub> ', 'L <sub>125</sub> ', 'B <sub>432</sub> ', 'D <sub>534</sub> ', 'L <sub>120</sub> ', 'J <sub>632</sub> ', 'D <sub>526</sub> '
<b>Moderate Susceptible</b>	3.70 ± 0.25	'L <sub>236</sub> ', 'L <sub>29</sub> ', 'L <sub>30</sub> ', 'L <sub>42</sub> ', 'Talash', 'J <sub>633</sub> ', 'D <sub>56</sub> ', 'J <sub>625</sub> ', 'B <sub>45</sub> ', 'B <sub>433</sub> ', 'B <sub>417</sub> ', 'L <sub>328</sub> ', 'L <sub>229</sub> '
<b>Moderate Resistant</b>	2.50 ± 0.35	'L <sub>31</sub> ', 'L <sub>329</sub> ', 'L <sub>321</sub> ', 'L <sub>16</sub> ', 'B <sub>425</sub> ', 'J <sub>29</sub> ', 'J <sub>67</sub> ', 'D <sub>3</sub> ', 'L <sub>25</sub> '
<b>Resistant</b>	1.20 ± 0.18	'L <sub>19</sub> ', 'L <sub>1</sub> '

**Table 2.** Comparison (mean ± SE) of two-spotted spider mite oviposition and mortality and leaf damage score on 35 lines of pinto bean in leaf disk bioassay.

Lines	No. eggs <sup>1</sup>	No. of alive mites <sup>2</sup>	No. of dead mites <sup>2</sup>	Damage score
'D <sub>521</sub> '	112.80 ± 18.53 a	4.20 ± 0.37 a-d	0.80 ± 0.37 h-k	5.50 ± 0.40
'J <sub>632</sub> '	100.80 ± 10.20 a-b	4.00 ± 0.54 a-e	1.00 ± 0.54 g-k	4.80 ± 0.37
'D <sub>524</sub> '	98.50 ± 14.14 a-b	3.75 ± 0.47 a-f	1.25 ± 0.47 f-k	5.00 ± 0.40
'D <sub>532</sub> '	95.00 ± 17.19 a-c	4.50 ± 0.50 a-c	0.50 ± 0.10 i-k	5.40 ± 0.24
'L <sub>323</sub> '	88.40 ± 13.68 a-d	4.00 ± 0.54 a-e	1.00 ± 0.14 g-k	5.00 ± 0.54
'J <sub>617</sub> '	82.75 ± 8.41 b-e	4.90 ± 0.10 a	0.10 ± 0.03 k	4.75 ± 0.25
'L <sub>236</sub> '	72.25 ± 13.68 b-f	3.70 ± 0.25 a-f	1.30 ± 0.25 f-k	3.50 ± 0.10
'L <sub>125</sub> '	71.00 ± 12.72 b-f	3.80 ± 0.37 a-f	1.20 ± 0.37 f-k	4.60 ± 0.24
'B <sub>432</sub> '	66.25 ± 11.34 c-g	4.75 ± 0.20 a-b	0.25 ± 0.05 j-k	4.75 ± 0.25
'D <sub>534</sub> '	66.20 ± 7.00 c-g	4.20 ± 0.37 a-d	0.80 ± 0.17 h-k	4.80 ± 0.20
'D <sub>526</sub> '	65.50 ± 5.33 c-g	3.00 ± 0.40 c-g	2.00 ± 0.40 c-i	5.00 ± 0.40
'L <sub>29</sub> '	64.50 ± 11.80 c-g	3.75 ± 0.62 a-f	1.25 ± 0.32 f-k	4.00 ± 0.70
'L <sub>30</sub> '	64.25 ± 10.80 c-g	3.50 ± 0.50 b-g	1.50 ± 0.50 e-j	4.25 ± 0.47
'L <sub>120</sub> '	61.00 ± 4.70 e-h	4.25 ± 0.25 a-d	0.75 ± 0.25 h-k	4.50 ± 0.28
'L <sub>42</sub> '	56.50 ± 6.65 e-i	2.25 ± 0.25 g-k	2.75 ± 0.25 a-e	4.25 ± 0.47
'Talash'	56.50 ± 5.55 e-i	3.33 ± 0.49 b-h	1.67 ± 0.49 d-j	4.17 ± 0.40
'L <sub>229</sub> '	51.20 ± 7.06 f-j	1.80 ± 0.48 i-k	3.20 ± 0.48 a-c	3.20 ± 0.58
'J <sub>633</sub> '	46.20 ± 4.36 f-j	2.00 ± 0.31 h-k	3.00 ± 0.31 a-d	4.00 ± 0.31
'D <sub>56</sub> '	44.80 ± 5.85 f-j	3.20 ± 0.66 c-g	1.80 ± 0.66 c-i	3.80 ± 0.48
'J <sub>625</sub> '	42.75 ± 7.65 f-j	4.00 ± 0.40 a-e	1.00 ± 0.40 g-k	4.00 ± 0.40
'B <sub>45</sub> '	42.40 ± 9.91 f-j	3.60 ± 0.40 a-e	1.40 ± 0.40 e-k	3.20 ± 0.48
'B <sub>433</sub> '	42.20 ± 6.37 f-j	1.80 ± 0.37 a-f	3.20 ± 0.37 a-c	3.20 ± 0.37
'L <sub>31</sub> '	38.75 ± 5.96 g-j	1.75 ± 0.47 i-k	3.25 ± 0.47 a-c	3.00 ± 0.40
'L <sub>329</sub> '	36.00 ± 6.98 g-j	1.20 ± 0.20 k	3.80 ± 0.20 a	2.80 ± 0.58
'L <sub>321</sub> '	35.00 ± 7.00 g-j	2.60 ± 0.40 e-k	2.40 ± 0.40 a-g	2.80 ± 0.37
'L <sub>16</sub> '	36.00 ± 4.21 g-j	2.60 ± 3.10 e-k	2.30 ± 0.80 a-g	2.60 ± 0.35
'B <sub>417</sub> '	35.00 ± 4.59 g-j	4.20 ± 0.37 a-d	0.80 ± 0.37 h-k	3.60 ± 0.40
'B <sub>425</sub> '	31.20 ± 6.80 h-j	1.80 ± 0.20 i-k	3.20 ± 0.20 a-c	3.00 ± 0.31
'L <sub>328</sub> '	30.80 ± 5.32 h-j	1.80 ± 0.66 i-k	3.20 ± 0.66 a-c	3.20 ± 0.37
'D <sub>3</sub> '	29.40 ± 3.82 h-j	3.40 ± 0.60 b-h	1.60 ± 0.60 d-j	3.00 ± 0.10
'J <sub>67</sub> '	27.80 ± 8.78 i-j	2.40 ± 0.40 f-k	2.60 ± 0.40 a-f	2.80 ± 0.66
'L <sub>19</sub> '	25.40 ± 8.93 i-j	1.40 ± 0.40 j-k	3.60 ± 0.40 a-b	1.80 ± 0.37
'J <sub>29</sub> '	24.00 ± 3.96 j	3.20 ± 0.37 c-g	1.80 ± 0.37 c-i	2.60 ± 0.37
'L <sub>25</sub> '	23.25 ± 4.57 j	2.00 ± 0.10 h-k	3.00 ± 0.10 a-d	2.25 ± 0.47
'L <sub>1</sub> '	22.00 ± 3.42 j	2.80 ± 0.37 d-j	2.20 ± 0.37 b-h	2.80 ± 0.37

<sup>1</sup>Number of eggs/5 females/3 days <sup>2</sup>number out of 5 mites

Lines with the same letter at each column are not significantly different at  $P = 0.05$

### Leaf damage

Kruskal-Wallis test showed significant differences among the treatments (Table 3). The highest level of damage (LDI) was observed on the leaf disk of 'D<sub>521</sub>' and 'D<sub>532</sub>' ( $5.50 \pm 0.40$  and  $5.40 \pm 0.24$ , respectively), whereas the leaf disk of 'L<sub>19</sub>' ( $1.80 \pm 0.37$ ) and 'L<sub>25</sub>' ( $2.25 \pm 0.47$ ) had the lowest values of LDI (Table 2).

### Overall performance

The correlation between mite oviposition and leaf damage score was strongly positive ( $R = 0.83$ ,  $P = 0.0001$ ) whereas, the correlations between mite mortality and leaf damage score was strongly negative ( $R = -0.62$ ,  $P = 0.0001$ ). The studied lines were classified into five groups, based on the overall performance in leaf disk bioassay. Mite response to the host (oviposition and mortality) and plant response to the mite (leaf damage score) were considered simultaneously as a measure of overall performance (Table 3). In the cluster analysis, lines 'D<sub>521</sub>', 'J<sub>633</sub>', 'D<sub>524</sub>' and 'D<sub>532</sub>' appeared to be highly susceptible and susceptible, whereas, lines 'L<sub>31</sub>', 'L<sub>329</sub>', 'L<sub>321</sub>', 'L<sub>16</sub>', 'B<sub>417</sub>', 'B<sub>425</sub>', 'L<sub>328</sub>', 'J<sub>29</sub>', 'J<sub>67</sub>', 'L<sub>19</sub>', 'D<sub>3</sub>', 'L<sub>25</sub>' and 'L<sub>1</sub>' appeared to be resistant to the TSSM (Table 3).

**Table 3.** Grouping of 35 lines of pinto bean, *Phaseolus vulgaris*, for resistance to *Tetranychus urticae* based on mean ( $\pm$  SE) mite oviposition, mite mortality and leaf damage score.

Clusters	No. eggs	Mite mortality	Leaf damage score	Lines
Highly Susceptible	$112.8 \pm 1.50$	$0.8 \pm 0.10$	$5.4 \pm 0.24$	'D <sub>521</sub> '
Susceptible	$98.1 \pm 2.92$	$0.92 \pm 0.38$	$5.1 \pm 0.36$	'J <sub>633</sub> ', 'D <sub>524</sub> ', 'D <sub>532</sub> '
Moderate Susceptible	$85.5 \pm 3.99$	$0.5 \pm 0.7$	$4.87 \pm 0.18$	'L <sub>323</sub> ', 'J <sub>617</sub> ', 'L <sub>236</sub> ', 'L <sub>125</sub> ', 'B <sub>432</sub> ', 'D <sub>534</sub> ', 'L <sub>526</sub> '
Moderate Resistant	$63.2 \pm 6.35$	$1.5 \pm 0.85$	$4.27 \pm 0.55$	'L <sub>29</sub> ', 'L <sub>30</sub> ', 'L <sub>120</sub> ', 'L <sub>42</sub> ', 'Talash', 'L <sub>229</sub> ', 'J <sub>633</sub> ', 'D <sub>56</sub> ', 'J <sub>625</sub> ', 'B <sub>45</sub> ', 'B <sub>433</sub> '
Resistant	$33.98 \pm 7.98$	$0.92 \pm 0.92$	$0.58 \pm 0.58$	'L <sub>31</sub> ', 'L <sub>329</sub> ', 'L <sub>321</sub> ', 'L <sub>16</sub> ', 'B <sub>417</sub> ', 'B <sub>425</sub> ', 'L <sub>328</sub> ', 'J <sub>29</sub> ', 'J <sub>67</sub> ', 'L <sub>19</sub> ', 'D <sub>3</sub> ', 'L <sub>25</sub> ', 'L <sub>1</sub> '

## DISCUSSION

Host plant quality affects the development, survival and fecundity of *T. urticae* (Uddin *et al.* 2015). Our results indicated that studied lines of pinto bean were significantly different in their suitability to the feeding, survival and oviposition of TSSM females (Table 2). Differences in host suitability for the mite are reported by several authors. Rasmy (1985) and Saeidi and Mallik (2006) studied differences in suitability of *Lycopersicon* species for the mite oviposition, survival and development. Mohammadi *et al.* (2015) studied reproductive parameters, life expectancy and life table parameters of this mite on six greenhouse cucumber cultivars. All of these studies suggested the existence of genetic factors which influence the suitability of the host plant for TSSM.

In the present study, 55 genotypes of *P. vulgaris* were screened using leaf disk bioassays based on the mite oviposition and mortality and plant damage score. This method has been used successfully for *in vitro* screening of several crops to the TSSM such as raspberry, *Rubus idaeus* L., (Wilde *et al.* 1991), strawberry, *Fragaria* sp. (Gimenez-Ferrer *et al.* 1993), tomato, *Lycopersicon* species (Saeidi and Mallik 2006), white bean, *P. vulgaris* (Mohammadi *et al.* 2013) and cucumber, *Cucumis sativus* L. (Mohammadi *et al.* 2015). The *in vitro* method (leaf disk bioassay) used here, is an effective method for studying resistance to the TSSM (Saeidi and Mallik 2006; Mohammadi *et al.* 2013) and clearly indicated differences among the tested lines (Tables 1–3). However, because the host environment relationship is extremely complex, selected lines should be subjected to complementary experiments under field conditions.

Studied lines were classified into five groups (highly susceptible, susceptible, moderate susceptible, moderate resistant and resistant) according to mite response to the host (oviposition and mortality) and host response to the mite (leaf damage score) (Table 3). Determining relative resistance among the host plants could be more clearly established when mite response to the host and host response to the mite are considered simultaneously as a measure of overall cultivar performance (Gimenez-Ferrer *et al.* 1993).

Differences observed among the treatments in the mite and plant responses may indicate the presence of genetic factors which influence antibiotic, antixenotic or tolerance mechanisms. According to Shoorooei *et al.* (2018), both antixenosis and antibiosis mechanisms to the TSSM were observed in resistant accessions of common bean. Among the 55 studied lines, only 13 lines were resistant to the TSSM (Tables 2, 3), which can be used as the source of resistance to the TSSM in future plant breeding programs. Understanding the genetic basis of resistance in the selected lines will facilitate transferring of resistant genes to the commercial cultivars of pinto bean. Resistant cultivars not only minimize pest damage and guarantee stability of production (Saeidi and Mallik 2006), but also present an appropriate solution to reduce application of dangerous-to-environmental-health pesticides (Fathipour and Sedaratian 2013).

Further experiments are therefore suggested to determine the mechanisms of resistance in the selected lines, as well as identifying morphological and physiological factors, which adversely affect development, survival, reproduction and life table parameters of the TSSM.

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### REFERENCES

- Bong, C.F.J., Sikorowski, P.P. & Davis, F.M. (1991) Effects of a resistant maize genotype and cytoplasmic polyhedrosis virus on growth and development of the corn earworm (Lepidoptera: Noctuidae). *Environmental Entomology*, 20: 1200–1206.  
DOI: 10.1093/ee/20.4.1200.
- Fathipour, Y. & Sedaratian, A. (2013) Integrated management of *Helicoverpa armigera* in soybean cropping systems, In: El-Shemy, H. (Ed.), *Soybean-pest resistance*. In Tech, Rijeka, Croatia, pp. 231–280.
- Gimenez-Ferrer, R.M., Erb, W.A., Bishop, B.L. & Scheerens, J.C. (1994) Host–pest relationship between the two spotted spider mite and strawberry cultivars with different levels of resistance. *Journal of Economic Entomology*, 87: 168–175.
- Gimenez-Ferrer, R.M., Scheerens, J.C. & Erb, W.A. (1993) *In vitro* screening of 76 strawberry cultivars for two spotted spider mite resistance. *Horticultural Science*, 28: 841–844.
- Godfrey, L.D. (2011) *Spider mites, integrated pest management for home gardeners and landscape professionals*. Publication No. 7405, University of California, Davis, CA95616, 4 pp.
- Khanamani, M., Fathipour, Y., Hajiqanbar, H. & Sedaratian, A. (2012) Reproductive performance and life expectancy of *Tetranychus urticae* (Acari: Tetranychidae) on seven eggplant cultivars. *Journal of Crop Protection*, 1(1): 57–66.
- Lorenzen, J.H., Balbyshev, N.F., Lafta, A.M., Casper, H., Tian, X. & Sagredo, B. (2001) Resistant potato selections contain leptine and inhibit development of the Colorado potato beetle (Coleoptera: Chrysomelidae). *Journal of Economic Entomology*, 94: 1260–1267.  
DOI: 10.1603/0022-0493-94.5.1260.
- Luczynski, A., Islam, M.B., Raworth, D.A. & Chan, C.K. (1990) Chemical and morphological factors of resistance against the two spotted spider mite in beach strawberry. *Journal of*

- Economic Entomology*, 83: 564–569.
- Modarres Najafabadi, S.S. & Zamani, A.A. (2013) The effect of common bean cultivars on life table parameters of *Tetranychus urticae* (Acari: Tetranychidae). *Persian Journal of Acarology*, 2(2): 297–310.
- Mohammadi, S., Saeidi, Z., Seraj, A.A., Nemati, A. & Babaian, E. (2013) Influence of seven white bean genotypes on biological parameters of two spotted-spider mite under laboratory conditions and evaluation of plant damage in greenhouse conditions. *Iranian Journal of Entomological Research*, 4(2): 171–180.
- Mohammadi, S., Seraj, A.A. & Rajabpour, A. (2015) Effects of six greenhouse cucumber cultivars on reproductive performance and life expectancy of *Tetranychus turkestanii* (Acari: Tetranychidae). *Acarologia*, 55(2): 231–242.  
DOI: 10.1051/acarologia/20152164.
- Panda, N. & Khush, G.S. (1995) *Host Plant Resistance to Insects*. CAB International, Wallingford, U.K., 431 pp.
- Riahi, E., Nemati, A., Shishehbor, P. & Saeidi, Z. (2020) Investigation on resistance of different peach cultivars to two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) in laboratory conditions. *Journal of Entomological Society of Iran*, 78(2): 213–222.  
DOI: 10.22117/jesi.2019.125899.1305.
- Nihoul, P., Hance, T. & Van-Impe, G. (1991) Characterizing indices of damage to tomato by the two-spotted spider mite, *Tetranychus urticae* Koch (Acari; Tetranychidae) to achieve biological control. *Journal of Horticultural Science*, 66: 643–648.
- Rasmy, A.H. (1985) The biology of the TSSM, *T. urticae* as affected by resistant *Solanum* plants. *Agriculture, Ecosystems and Environment*, 13: 325–328.
- Saeidi, Z. (2013) Investigation on resistance of different almond cultivars/genotypes to two-spotted spider mite, *Tetranychus urticae* Koch in laboratory and greenhouse condition. *Journal of Entomological Research*, 5(4): 353–364.
- Saeidi, Z. & Mallik, B. (2006) *In vitro* screening of 67 *Lycopersicon* accessions/cultivars for resistance to two-spotted spider mite. *Journal of Biological Sciences*, 6: 847–853.
- Saeidi, Z. & Salehi F. (2005) Study on the resistance to two-spotted spider mite in selected lines from Lordegan chitti bean variety. *Journal of Applied Entomology and Phytopathology*, 73(1): 65–77.
- Sedaratian, A., Fathipour, Y. & Moharrampour, S. (2009) Evaluation of resistance in 14 soybean cultivars to *T. urticae* (Acari: Tetranychidae). *Journal of Pest Science*, 82: 163–170.
- Shoorooei, M., Hoseinzadeh, A.H., Maali-Amiri, R., Allahyari, H. & Torkzadeh-Mahani, M. (2018) Antixenosis and antibiosis response of common bean (*Phaseolus vulgaris*) to two spotted spider mite (*Tetranychus urticae*). *Experimental and Applied Acarology*, 74: 365–381.  
DOI: 10.1007/s10493-018-0240-4
- Stenberg, J.A. (2017) A conceptual frame work for integrated pest management. *Trends Plant Science*, 22: 759–769.  
DOI: 10.1016/j.tplants.2017.06.010
- Uddin, M.N., Alam, M.Z., Miah, M.R.U., Mian, M.I.H. & Mustarin, K.E. (2015) Life table parameters of *Tetranychus urticae* Koch (Acari: Tetranychidae) on different bean varieties. *African Entomology*, 23(2): 418–426.  
DOI: 10.4001/003.023.0231
- Wilde, G., Thomas, W. & Hall, H. (1991) Plant resistance to two spotted spider mite (Acari: Tetranychidae) in raspberry cultivars. *Journal of Economic Entomology*, 84: 251–255.

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## غربالگری ۵۵ لاین لوبیا چیتی برای مقاومت نسبت به کنه تارتن دولکهای، *Tetranychus urticae* Koch (Acari: Tetranychidae)

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### چکیده

کنه تارتن دولکهای (*Tetranychus urticae* Koch) به عنوان مهم‌ترین آفت لوبیا در مناطق مختلف جهان به شمار می‌رود. در این پژوهش، ۵۵ لاین از بین ژرم‌پلاسم‌های مختلف لوبیا چیتی انتخاب و برای مقاومت نسبت کنه تارتن دولکهای در دو مرحله مورد بررسی قرار گرفتند. در مرحله نخست، لاین‌ها براساس شدت خسارت وارده به دیسک‌های برگ (از ۰، بدون خسارت تا ۶، لکه‌های تغذیه‌ای بیش از ۸۰ درصد از سطح برگ)، در پنج گروه قرار گرفتند. ۲۱ لاین بیش‌ترین شاخص خسارت را نشان دادند ( $LDI = 5/30 \pm 0/27$ )، بنابراین، در این مرحله حذف شدند. به جز لاین 'D521'، که به عنوان شاهد حساس مورد استفاده قرار گرفت. در مرحله دوم، ۳۴ لاین با شاخص خسارت کم‌تر از ۴، به همراه لاین 'D521' (شاهد حساس) با استفاده از روش دیسک برگ مورد مطالعه قرار گرفتند. نتایج به دست آمده نشان داد که بیش‌ترین میزان تخم‌ریزی در لاین‌های 'D521' ( $7/52 \pm 1/23$ ) تخم برای هر کنه ماده در روز) و کم‌ترین میزان تخم‌ریزی در لاین‌های 'L1'، 'J29' و 'L19' (به ترتیب  $1/46 \pm 0/23$ ،  $1/60 \pm 0/26$  و  $1/69 \pm 0/59$ ) مشاهده شد. بیش‌ترین تعداد کنه‌های زنده روی لاین‌های 'J617' و 'B432' (به ترتیب  $5 \pm 0/10$  و  $4/75 \pm 0/20$ ) عدد کنه از ۵ کنه رهاسازی شده) و کم‌ترین تعداد کنه‌های زنده روی لاین‌های 'L329' و 'L19' (به ترتیب  $1/2 \pm 0/20$  و  $1/4 \pm 0/40$ ) دیده شد. لاین‌ها بر اساس واکنش کنه نسبت به میزبان (میزان تخم‌ریزی و مرگ و میر کنه) و واکنش میزبان نسبت به کنه (شاخص خسارت) در پنج گروه قرار گرفتند. بر اساس تجزیه خوشه‌ای، لاین‌های 'D521'، 'J633'، 'D532' و 'D524' نسبت به کنه تارتن دولکهای حساس بودند در حالی‌که لاین‌های 'L31'، 'L329'، 'L321'، 'L16'، 'L417'، 'B425'، 'L328'، 'J29'، 'J67'، 'L19'، 'D3'، 'L25' و 'L1' نسبت به آفت مقاوم بودند. این لاین‌ها به عنوان منابع مقاومت به کنه تارتن دولکهای در برنامه‌های اصلاح گیاهان می‌توانند مورد استفاده قرار گیرند.

**واژگان کلیدی:** تجزیه خوشه‌ای؛ آلودگی؛ شاخص خسارت برگ؛ زیست‌سنجی؛ دیسک برگ؛ حساسیت.

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