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Full Length Research Paper

Resistance of eight Iranian onion cultivars to onion thrips (*Thrips tabaci* Lindeman) in the Markazi Province of Iran

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***Thrips tabaci* L. is one of the most important pests of onion in Iran. In this research, eight Iranian onion cultivars (Ghermez-e-Azarshar, Sefid-e-Kashan, Sefid-e-Native Khomein, Sefid-e-Improved Khomein, Sefid-e-Qom, Sefid-e-Kordestan, Sefid and Ghermez-e-Shahroud) were cultivated in a RCB design with four replications in Arak, between 2001 and 2003. The number of thrips on five plants was recorded every two weeks and ten days interval on non-sprayed and sprayed plots, respectively. The symptoms of pest feeding, which includes chlorosis and necrosis were rated based on a scale from 1 to 10 for usual damaging and leaf curling another symptom a 1 to 6 scale. The control field was sprayed with current insecticides every 10 days in order to decrease the thrips population. In this study, the highest number of thrips was observed on Ghermez-e-Azarshahr, Sefid-e-improved Khomein and Sefid-e-Shahroud and the lowest number was recorded on non-sprayed fields and then on Ghermez-e-Shahroud and Sefid-e-Kordestan. The highest amount of damage was observed on Ghermez-e-Azarshahr while, the lowest one for Sefid-e-Kordestan and Qom. In non-sprayed plots, the highest yield was recorded for Sefid-e-Kashan and Qom cultivars and the lowest yield for Sefid-e-Kordestan cultivar. The results of the study over the three years showed Sefid-e-Kashan and Sefid-e-Qom as the genotypes resistant to thrips, Sefid-e-improved onion of Khomein as a tolerant genotype and Ghermez-e-Azarshahr having high level of thrips density (more than 25 thrips in each plant) and high level of damage, and leaf curling is introduced as a genotype sensitive to thrips.**

Key words: Onion cultivar, *Thrips tabaci*, resistance.

INTRODUCTION

Onion, *Allium cepa* L. belongs to the Alliaceae family and possesses the highest nutritional values in providing necessary vitamins and salts. Onion as an important medicinal plant has a particular status in the food chain (Rabin et al., 1990). Every year, thrips of onion, *Thrips tabaci* L. imposes many economical damages on onion crops. This damages observed by this pest include scarring, leaf curling, reduction in the size of onion, yield and seed reduction. If the damages by thrips were intensive, the plant would become faded and killed (Khanjani, 2005). Continuous use of insecticides has lead to resistance (Coudriet et al., 1979). One of the approaches to minimize the damage is the use of genotypes resistant to this pest (Sinha et al., 1993). The effects of thrips on the growth stages of this plant; include growth stage of the plant and bulb formation. Each ten thrips on a plant may cause a 2 to 3% decrease in yield in the field conditions and a 7% decrease in greenhouse condition (Kendall and Capniera, 1987). Moghadan et al. (2000) introduced the Sefid-e-Qom and Sefid-e-Kashan as the genotypes resistant to thrips among the native genotypes of Iranian onions. Bagheri (2000) among the imported genotypes of onion to Iran introduced Mercedes genotype as a resistant genotype against this pest. Hemmati and Benedictos (2000), while evaluating the

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resistance of 219 native genotypes of onion against thrips concluded that all the cultivated genotypes in foliating and flowering stages showed an average sensitivity to this pest, but at the seedling stage showed intensive sensitivity. Eight cultivars among other cultivars showed a relative acceptable tolerance to this pest in the foliating stage. In their research, it has been concluded that the presence of wax on the leaves had a direct relation with onion sensitivity to thrips. The wax coating on leaves acts as a factor that attracts thrips and increases the degree of sensitivity in these genotypes (Molenaar, 1984). Molenaar (1984) demonstrated that the gene controlling the fading of leaves has dominance over the gene controlling the shining of leaves and the former gene is epistatic toward the gene controlling the shining of stems. It was reported that mechanism of resistance to thrips is antixenosis. Mote and Sonone (1977) studying on 46 onion genotypes concluded that the shiny onion genotype shows more resistance to thrips. Patil et al. (1988) by evaluating 28 Iranian and imported onion genotypes concluded that the genotypes with larger leaf angles, exhibit more resistance to thrips.

Mousavi et al. (2007) reported that the genotypes of Meshkan, Sefid-e-Kordestan, Sefid-e-Qom, and Sefid-e-Eghlid in comparison to other genotypes are affected to lesser extent by thrips which could be due to lower wax on the leaves. Edelson et al. (1991) evaluated the sensitivity of 10 onion genotypes to thrips in Texas, and concluded that there is an interaction between relationship (sprayed and non-sprayed) and the genotypes. Kendall and Capniera (1987) in their studies reported a significant correlation between the number of thrips and yield in bulb formation stage. The studies of Shirck and Douglass (1956) indicated that if the level of infection by thrips in onion farm is high, the final yield significantly decreases. In this connection, Mayer et al. (1987) have reported that the decrease in the number of thrips had no effect on the increase in the yield of the product. Lall and Singh (1968) by comparing the average number of thrips on eight onion genotypes introduced the Spanish Sefid and Ghermez-e-pona as the highest resistant and sensitive genotypes respectively.

Considering the high level of damage to thrips in the onion fields of Iran, this research was performed with the aim of finding the resistant genotypes to thrips in order to obtain desirable yield, therefore, it could be considered as a practical measure in decreasing the use of insecticides and in producing organic onion.

MATERIALS AND METHODS

During the years of 2001 to 2003, two tracts of land, each with approximate five hundred square meters area, with a distance of 10 m from each other in the agricultural research station of Arak, were chosen. The operation of lands carried out in the September of each year. The seeds of different onion genotypes were planted on the prepared mounds 5 m long and 75 cm width in 4 longitudinal rows. In order for the onion to sprout easier from the land, some washed sand was sprinkled and mixed with animal fertilizer on the seeds; this layer had 1 to 2 cm thickness. In order to control the weeds, appropriate herbicide (Goal in recommended dosage) was used in onion-farm, and to control *Agrotis* pests, Bait with Sevin at a ratio of 100 kg per ha was applied (according to: 100 kg wheat bran + 1.5 kg Sevin + 50 L water + some sugar). Fertilizer supply was based on trialing of the station soil and under the recommendation of water and soil department. Other agricultural operation, including the needed irrigation, weeding and pruning the plants were performed every 4 to 7 days.

In this research, the genotypes of Ghermez-e-Azarshahr, Sefid-e-Kashan, Sefid-e-Khomein, Sefid-e-Qom, Sefid-e-Kordestan, Sefid and Ghermez-e-Shahroud and the improved Sefid-e-Khomein genotype were evaluated in a completely randomized blocks with 4 replications. This project was carried out based on two independent trials: Sampling to measure intended characteristics, performed from 17 June to the beginning of September; in the sprayed, weekly, and in non-sprayed trails, every 15 days. The runtime and method of the two trials were completely equal. In the first trial (non-sprayed), the density of thrips in each plant, the amount of damage and leaf curling resulting from this pest and also the yield of the trialed genotypes were recorded. In the second trial (sprayed), the amount of damage and leaf curling caused by thrips, and eventually the yield of the genotypes were recorded. The essential information of the two trials was taken identically and synchronously. The area of each plot was 5.6 sq/m, and the samples were collected from the middle of each plot, that is; half a meter from the upper part and half a meter from the lower part of the plot was left out, thus, the sampling area was just 2.1 sq/m. The kind of used pesticide, and the number of spraying was chosen based on the conditions of the year and according to the custom of that region (between every 8 to 10 times a year). The used pesticides included, Oxydemeton methyl (1.5 L/ha), Etrimefos (1.5 L/ha), Thiometon (1.5 L/ha), Heptenophos (1.5 L/ha), Thiodicarb (1.5 L/ha), Imidacloprid (1 L/ha) and Fenitrothion (1.2 L/ha). And in each spraying, one kind of pesticide was used.

Evaluation of the damage and leaf curling

The apparent damage resulting from thrips was evaluated according to the changes that occurred in leaf color (symptom of chlorosis, necrosis, silvery spots and scarring), deformation and leaf curling, on five bushes from each genotype in each replication . The evaluation of the amount of damage and leaf curling was performed according to the methods of Cardona et al. (2002) and Feri et al. (2003).

The evaluation of damage, according to the changes of leaf color and the occurrence of silvery spots on leaves were scored based on a 1 to 10 nominal ranking scale:

1: Healthy plant, 2: the occurrence of tiny silvery spots on leaves (smaller than 1 mm) 3: the occurrence of medium silvery spots on leaves (about 1 to 5 mm), 4: the occurrence of large silvery spots with the diameter of 0.5 to 1 cm on leaves, 5: the occurrence of continued silvery spots with the diameter of 1 to 2 cm on leaves, 6: the occurrence of continued silvery spots with the diameter of 3 to 4 cm on leaves, 7: The silvery spots in the form of a band on the whole leaf, 8: The silvery spots in the form of a band on the whole leaf and the destruction of the one- third of leaves, 9: The silvery spots in the form of a band and the destruction of the two-third of leaves, and 10: the destruction of the whole plant.

The evaluation of apparent damage according to the deformation and leaf curling were scored based on a 1 to 6 nominal ranking scale:

1: The lack of curling in leaves, 2: The occurrence of curling in one-fifth of leaves in each bush, 3: The occurrence of curling in two-fifth

of leaves in each bush, 4: The occurrence of curling in three-fifth of leaves in each bush, 5: The occurrence of curling in four – fifth of leaves in each bush, 6: The occurrence of curling in the whole of leaves.

The density of thrips

Five plants from each genotype in every replication were chosen and collected randomly from the margin of the plots. The whole of the plants and their leaves were picked up and transferred to the laboratory in plastic bags. These samples were kept in the refrigerator for 24 h then; thrips were counted later on.

Ripening

As the time of ripening in various onion genotypes, differs according to the percent of the greenness of plants and the time of bulb-formation, so the time of ripening of genotypes was registered from 10 to 15 September of each year.

The angle of leaves

To measure the angle of leaf, 10 plants out of each genotype were chosen, and then the angle of the second leaf towards the stem was measured with a protractor. This measurement was done in three stages (in the beginning of July, August and September).

Data analysis

The data obtained from the evaluation of observation in the two trials were gathered separately during 3 years and finally, they were analyzed using the GLM procedure of the SAS program (1989) in completely randomized blocks. The comparison of the means of observations was performed according to the method of Duncan's multi-dominance trial.

RESULTS AND DISCUSSION

The compound variance analysis of the average of thrips density in the non-sprayed trial indicated a significant difference ($P < 1\%$). Among the examined genotypes, year and the replications in the sprayed trial, the difference was significant ($P < 1\%$). The comparison of the averages using Duncan's test indicated that in non-sprayed trial, Ghermez-e-Azarshahr, Sefid-e-Shahrood, and Ghermez-e-Shahrood genotypes, with density of 27.7, 25.7 and 25.3 showed the highest number of thrips, and Sefid-e-Kordestan and Sefid-e-Qom genotypes with density of 16 and 15.8 showed the lowest number of thrips among other genotypes (Table 2). In the sprayed trail, the highest number of thrips was recorded for Ghermez-e-Azar shahr genotype 24.8 numbers for each plant respectively, and the lowest number was recorded for Sefid-e-Qom and Sefid-e-Kordestan genotypes 17.2 and 18.1 numbers for each plant respectively. The results of this research indicated that the attraction of thrips by the various genotypes of onion depends on some factors, such as the presence of wax and the color of the plants. In this study, Ghermez-e-Azarshahr and Sefid and Ghermez-e-Shahrood, which had wax on their leaves were darker than other genotypes, they presented more thrips. The genotypes such as Sefid-e-Qom and Sefid-e-Kordestan which lacked wax and had lighter color than the other genotypes showed lower number of thrips. The current results regarding the lower density of thrips on Sefid-e-Qom and Sefid-e-Kordestan indicate the presence of wax and the lighter color correspond to the results of Mousavi et al. (2007). The amount of thrips density on improved Sefid-e-Khomein genotype, due to the presence of wax and a lighter color than other genotypes was high. In the present work, the effects of genotype and spraying on thrips density was significant ($P < 1\%$), but the interaction of the genotypes to the pesticide was different. The density of thrips on Sefid-e-Qom genotype in both trials (sprayed and non-sprayed) were 17.2 and 15.8 respectively, but this density on Ghermez-e-Azarshahr genotype in both trials was higher than others; that is 24.8 and 27.6 thrips in each plant. The current results, regarding the ineffectiveness of spraying in decreasing the pest density on Sefid-e-Qom genotype, corresponded with the results of Kalafchi et al. (2005), but differs regarding the significant effect of spraying in decreasing the thrips density on Ghermez-e-Azarshahr genotype, as they had used a kind of insecticide which was not recommended, persistent in environment and inapplicable in farms. But in the current research an insecticide was used which is non persistent in the environment and applicable in onion-farms. The results of current research was consistent with the results of Molenaar (1984), in which it was proved that the wax coating on leaves acts as a factor of attraction of thrips, and to the results of Mote and Sonone (1977) regarding the higher tolerance of shiny genotypes and the ones with lighter color to thrips.

The compound variance analysis resulting from this factor indicated a significant difference in the onion genotypes, years and the effect of interaction of the year on the genotype and the replications in both trials (sprayed and non-sprayed) ($P \leq 1\%$, $P \leq 5\%$), (Table 1). The results of the comparison of means using Duncan's test showed that in non sprayed trial, Ghermez-e-Azarshahr and Sefid-e-Shahrood genotypes with scale of 6.04 and 5.58 had the maximum signs of damage, and Sefid-e-Qom and Sefid-e-Kordestan genotypes with scale from 3.9 and 3.8 had the minimum signs of damage (Table 2). In sprayed trial, the maximum level of damage was attributed to the Ghermez-e-Azarshahr and Ghermez-e-Shahrood genotypes with scale of 6.2 and 6.2, and the minimum level of damage to Sefid-e-Kordestan and Sefid-e-Qom with scale of 4.7 and 4.4 (Table 3).

The compound variance analysis of leaf curling, indicated a significant difference among the genotypes, years and the effect of interaction of year on the genotypes in the sprayed trial ($P \leq 1\%$, $\leq 5\%$), (Table 1). The results of the comparison of the means using Duncan's test showed that in non sprayed experiment,

Table 1. Combined ANOVA for effective parameters of resistance to thrips in eight Iranian onion cultivars.

Source of variation	df	MS											
		Density of thrips		Damage		Curling		Yield		Ripping		Leaf angle	
		Spraying	Non-spraying	Spraying	Non-spraying	Spraying	Non-spraying	Spraying	Non-spraying	spraying	Non-spraying	Spraying	Non-spraying
Year (A)	2	363.1**	593.6**	31.1**	8.43**	6.51*	17001.2**	31893.6**	770.7**	54.9**	2.1**	796.8**	2881.6**
Error (a)	9	94.7	91.6	0.6	0.54	1.96	20.6	13.3	155.7	0.23	1.6	9.1	2.25
Cultivar(B)	7	58.03*	291.6**	4.2**	7.5**	4.35*	1876.4**	1336.05**	482.7**	4.05**	3.9**	354.3**	264.9**
A × B	14	337*	121.7**	6.3**	3.2**	7.51*	1480.8**	18.6.05**	553.8**	20.2**	1.5**	140.1**	79.2**
Error(b)	63	22.1	26.1	0.17	0/3	0.12	21.5	30	65.4	0.46	0.34	5.5	7.9
CV%		22.2	24.7	7.4	11.1	10.3	6.9	9.8	11.9	14.4	11.1	9.5	9.5

* and ** : Significant at the 5 and 1% probability levels, respectively; ns: non significant.

Table 2. Mean comparison of different onion cultivars based on some morphological characters related to resistance of thrips on non-spraying.

Cultivar	Density of thrips (Number/Plant)	Damage (1-10)	Curling (1-6)	Yield (T/ha)	Ripping (%)	Leaf angle (°)
Ghermez – e –Azarshar	27.6^{a}	6.04^{a}	3.01^{a}	70.1^{bc}	25.05^{c}	30.84^{b}
Sefid – e –Kashan	20.8^{b}	4.52^{c}	2.63^{bc}	79.2^{a}	34^{b}	33.9^{a}
Native Sefid – e –Khomein	16.7^{bc}	4.96^{c}	2.57^{bc}	70.2^{bc}	95.5^{a}	22.36^{c}
Sefid – e –Qom	15.8^{c}	3.9^{d}	2^{d}	75.1^{ab}	13.3^{d}	31.5^{ab}
Improved Sefid – e- Khomein	17^{bc}	4.8^{c}	2.32^{bc}	62.9^{cd}	96.3^{a}	22.07^{c}
Sefid – e –Shahrood	25.7^{a}	5.58^{b}	2.79^{ab}	62.9^{cd}	28.5^{bc}	32.7^{ab}
Sefid– e - Kordestan	16^{c}	3.84^{d}	2.05^{d}	61.05^{d}	31.1^{bc}	32.2^{ab}
Ghermez – e -Shahrood	25.3^{a}	5.55^{b}	2.77^{ab}	67.2^{cb}	34.1^{bc}	31.75^{ab}

Mean followed by similar letters in each column are not significantly different at the 5% level using Duncan's multiple range test.

Table 3. Mean comparison of different onion cultivars based on some morphological characters related to resistance of thrips on spraying.

Cultivar	Density of thrips (Number / Plant)	Damage (1-10)	Curling (1-6)	Yeild (T/ha)	Ripping (%)	Leaf angle (°)
Ghermez – e -Azarshar	24.8^{a}	6.20^{a}	3.41^{ab}	70.03^{ab}	34.9^{b}	24.2^{cd}
Sefid – e -Kashan	$19.4b^{c}$	5.05^{c}	3.56^{a}	78.5^{a}	21.2^{c}	33.38^{a}
Native Sefid – e –Khomein	20.99^{abc}	5.70^{b}	3.34^{ab}	66.8^{ab}	86.5^{a}	19.69^{d}
Sefid – e -Qom	17.2^{c}	4.7^{cd}	2.8^{c}	70.8^{ab}	0.667^{d}	17.6^{e}
Improved Sefid – e- Khomein	22.06^{abc}	5.85^{ab}	3.49^{a}	63.5^{b}	95.8^{a}	19.2^{d}
Sefid – e -Shahrood	22.4^{abc}	6.13^{ab}	3.51^{a}	64.2^{b}	20.26^{c}	27.6^{c}
Sefid– e - Kordestan	18.1^{c}	4.4^{d}	3.04^{bc}	58.2^{c}	22.5^{c}	30.6^{b}
Ghermez – e -Shahrood	24.1^{ab}	6.21^{a}	3.40^{ab}	68.7^{ab}	27.25^{bc}	23.3^{cd}

Mean followed by similar letters in each column are not significantly different at the 5% level using Duncan's multiple range test.

the maximum amount of curling was observed in Ghermez-e-Azarshahr and Sefid-e-Shahrood genotypes with a scale of 3.01 and 2.8, and the minimum amount of curling was observed in Sefid-e-Kordestan and Sefid-e-Qom with a scale of 2.1 and 1.99 (Table 2). In the sprayed trial, the maximum amount of curling was observed in Sefid-e-Kashan, Sefid-e-Shahrood, and native Sefid-e-Khomein and Ghermez-e-Shahrood genotypes, with scale of 3.6, 3.5, 3.4 and 3.4 and the minimum amount of curling was observed in Sefid-e-Qom genotypes with the scale of 2.8 (Table 3). The results indicated that the genotypes such as Ghermez-e-Azarshahr, Sefid and Ghermez-e-Shahrood, which had more wax and were darker than other trialed genotypes, have attracted more thrips, and hence, the observed damage and curling on them was higher. The genotypes such as Sefid-e-Qom and Sefid-e-Kordestan, which had less wax and lighter color, attracted less thrips, so the evaluated damage on them was lower than other ones; this result is the indication of a positive correlation between the thrips density and the amount of damage and occurrence of curling in leaves. These results are in agreement with those of Mousavi et al. (2007) regarding the low level of damage and infestation by the pest because of lack of wax. Because of having wax on the leaves and being darker than other genotypes, the level of thrips density in improved Sefid-e-Khomein is higher and symptom of damage was higher than the average. The results of current research are consistent with the results of Hemati and Benedictos (2000) regarding the evaluation of the damage in the cultivated genotypes at the stages of foliating and flowering with the average scale of 6.4 and 6.3. The results of this research are also in agreement with the results of Mote and Sonone (1977) which indicated that, genotypes with shiny and lighter colors have a higher resistance to thrips. Eventually, the current results regarding the effects of wax, leaf color and leaf angle on thrips density completely confirmed those of Bocak (1995), Codriet et al. (1979) and Moritz (1997).

The compound variance analysis of yield indicated that in non sprayed trial, there was a significant difference ($P \leq 1\%$), among the genotypes, the years and the effect of interaction of the year on genotypes ($P \leq 5\%$). In sprayed trial, the observed difference in the trialed cultivars ($P \leq 5\%$), years and the effect of interaction of the year on the genotype was significant ($P \leq 1\%$) (Table 1). The comparison of means using Duncan's test showed that in non sprayed trial, the maximum amount of yield belonged to Sefid-e-Kashan and Sefid-e-Qom genotypes (79.2 and 75.2 T/ha) and the minimum amount for Sefid-e-Shahrood, improved Sefid-e-Khomein and Sefid-e-Kordestan genotypes (63, 62.9 and 61.1 T/ha respectively), (Table 2). In sprayed trial, the maximum level of yield belonged to Sefid-e-Kashan and Sefid-e-Qom genotypes (78.5 and 70.8 T/ha respectively) and the minimum level belonged to Sefid and Ghermez-e-Shahrood and Sefid-e-Kordestan genotypes (64.2, 63.5 and 58.2 T/ha respectively), (Table 3). The results of the trial during 3 years showed that the average amount of yield in the two experiments was equal to 68.6 T/ha (non sprayed) and 67.6 T/ha (sprayed), thus the observed difference was not statistically significant and this indicates that the current spraying (8 to10 times each year) has no significant effect neither on decreasing thrips density nor on increasing the yield. And it leads to the augmentation causes of production costs and environmental pollution and destroys the natural enemy of thrips and harmful residue of the product; as a result such an action has no significant and useful effect on the onion-planter's revenue and economy. The results regarding the ineffectiveness of spraying on controlling the thrips and increasing the product yield is consistent with that of Moghadan et al. (2000). Evaluating the amount of yield in the bulbs indicated that there were no significant differences between the plants being sprayed with insecticide and those not being sprayed regarding their mean amount of yield. This result was similar to Mayer et al. (1987) but was different from Shirck and Douglass (1956) and Edelson et al. (1987). One of the differences between the current result and that of Kendall and Capniera (1987) is that they had evaluated the correlation between thrips' density and onion yield at the stage of bulb-formation, as significant, but the final yield of the product had not been considered, so this is one of the reasons of the difference between the two results. Genotypes' genetic characteristics and environmental conditions such as day length are among the reasons of the differences between the current and other results. Brewster et al. (1977) considered the short period of plant growth as a factor which hinders the plant to absorb the sunlight completely, thus, the amount of yield invarious genotypes would be decreased.

The compound variance analysis of ripening showed that the effect of the year, the genotype and the year on the genotype was significant ($P \leq 1\%$ and $P \leq 5\%$), (Table 1). The comparison of the means using Duncan's test indicated that in the two experiments, sprayed and non sprayed, the highest amount of the product ripening was observed in improved Sefid-e-Khomein and native Sefid-e-Khomein (96.3 and 95.5%) and the lowest amount was observed in Sefid-e-Qom (13.3%), (Tables 2 and 3). The results of this research showed that, at the end of the growth stage (from the beginning of September) thrips' density on some genotypes increases abruptly and as a result the level of imposed damage increases and the yield decreases. The early ripening of one genotype has an important role in lowering the symptom of damage, attracting the thrips and increasing the yield of the product. In this connection, improved Sefid-e-Khomein in comparison to the other genotypes ripened earlier, thus, this makes the onion leaves woody and due to this thrips density and the amount of damage on this genotype would decrease significantly. This appropriate morphological characteristic makes thrips escape away from this

genotype and this pest migrates toward other genotypes. The present results agree with those of Edelson et al. (1991) and Mobli et al. (2002).

The compound variance analysis of leaf angle indicated a significant difference in the effect of the year, genotype and the year on genotype in the both the experiments (P ≤ 1% and P ≤ 5%), (Table 1). The comparison of the means using the Duncan's test, showed that in the two trials (sprayed and non sprayed), the maximum angle of leaf was observed in Sefid-e-Kashan (about 33.9°) and the minimum angle in native Sefid-e-Khomein, Improve Sefid-e-Khomein and Sefid-e-Qom genotypes (22.4, 22.1 and 17.6° respectively), (Tables 2 and 3). Due to the thrips' behavior to hide in refuge and dark places (inter leaves), so the embowel of the leaves makes thrips escape from these genotypes and as such the amount of thrips density and damage would be decreased.

In the present study, the damages on Sefid-e-Kashan genotype are lower compared to other genotypes because of having the maximum angle of leaf. These results accorded with that of Patil et al. (1988).

It can be concluded that improved Sefid-e-Khomein genotype with an average density of thrips (17 thrips in each plant), average of damage and leaf curlings (4.7 and 2.33 respectively) having a desirable yield during the trialed years (average 63.2 T/ha) and considering other morphological characteristics such as the highest storage quality and early ripening is introduced as a tolerance genotype to thrips. Ghermez-e-Azarshahr by having high level of thrips density (more than 25 thrips in each plant), high level of damage and leaf curlings is introduced as a genotype sensitive to thrips and Sefid-e-Kashan and Sefid-e-Qom screened as genotypes resistant to thrips.

It is also concluded that spraying has no significant effect on decreasing the density of thrips and increasing the level of product yield in the two trials (sprayed: average 21.2 thrips in each plant, 67.6 T/ha and non-sprayed: average 20.6 thrips in each plant, 68.6 T/ha).

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