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Evaluation of Iranian Onion Germplasms for Resistance to Thrips

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ABSTRACT

The onion thrips (*Thrips tabaci* Lindeman) is the major foliage pest in field cultures of Iran. Since, there is little information about resistance of these genotypes to thrips this experiment was carried out (1) to find the resistant genotypes to thrips, (2) to evaluate the traits related to thrips resistance of 15 Iranian onion genotypes and (3) to identify promising materials for preservation and breeding programes. Results showed that genotypes "Meshkan", "Sefid- e- Kurdistan", "Sefid- e- Qom" and "Eghlid" had the lowest thrips number, percentage of leaf infestation, leaf wax in comparison to susceptible genotypes. Genotypes with glossy foliage were resistant and genotypes with non-glossy foliage were susceptible to thrips. Therefore, thrips-resistant Iranian onions could be used for crossing with susceptible genotypes and producing resistant cultivars.

Key Words: *Allium cepa* L.; *Thrips tabaci* Lindeman; Susceptible; Leaf wax

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable of alliaceae family, and central Asia is regarded as a center of its domestication (Brewster, 1994). Planted area and mean yield of onion in Iran are about 50000 ha and 30 t ha^{-1}, respectively (FAO, 2003). There are more than 15 Iranian onion genotypes cultivated by growers. Iranian onions have good horticultural characteristics e.g., long storability, good shape and marketable. The onion thrips (*Thrips tabaci* Lindeman) is the major foliage pest in field cultures of Iran. It is estimated that yield loss caused by thrips in Iran is more than 50% (personal communication).

Growers use different pesticides for several times, but most of them are ineffective, because large numbers of thrips are always protected between the inner leaves of the onion plant; the pupal stage is spent in the soil. The species is very prolific, the generations overlap, natural parasites are lacking and alternate hosts are numerous. Morphological characters, especially round or flat- sided leaves and open plant architecture, have been associated with low thrips densities on onion cultivar (Coudriet *et al*., 1979). Patil *et al*. (1988) found that a small angle of contact of leaves between, which insect prefer to contributes towards an increased thrips population of the varieties possessing such leaves. Varieties with round leaves have smaller populations, which however could be increased by fastening the round leaves together to cause more extensive contact between them (Painter, 1951). So shape (cross- section) of the leaves of onion seems to be one of the most important morphological markers, which have an influence on the oviposition of thrips.

Jones *et al*. (1934) studied the effect of leaf arrangement of onion variety on infestation by thrips, which lives and breeds between the inner leaves. Susceptible onion varieties have flat leaf surface pressed against each other, providing protected area for thrips to accumulate there. However, "White Persian" onion, the most resistant variety, has leaves with an almost circular cross-section that diverge a large angle, so providing for less protection (Jones *et al*., 1934). White cultivars of onion seem less susceptible to attack than red ones (Lall & Singh, 1968; Verma, 1996). Glossy foliage offers a degree of resistance probably due to differences in the chemistry of leaf waxes (Molenaar, 1984). Several studies (Hemmati & Benedictus, 2000; Nouri Moghaddam *et al*., 2004) were indicated that resistant onion populations had lower leaf wax content than susceptible ones. Monzen (1926) reported that a greater pH of the plant sap caused resistance of apple stocks to the woolly aphid. Comes (1917) stated that acidity of the plant sap caused by organic acids afforded protection and malic was considered the most toxic. Andrews (1921) mentioned that ratio of potash to phosphoric acid in resistant tea plant was twice than normal (4: 1 in comparison to 2: 1).

Since, there is little information about resistance of Iranian onion genotypes to thrips this experiment was carried out (1) to find the resistant genotypes to thrips, (2) to evaluate the traits related to thrips resistance and (3) to identify promising materials for preservation and breeding programs.

MATERIALS AND METHODS

Seeds of 15 Iranian onion genotypes were collected from the main production regions. Genotypes were "Sefid- e- Qom, Sefid- e- Kurdistan, Sefid- e- Kashan, Sefid- e-

Naishabur, Sefid- e- Khomein, Ghermez- e- Azarshahr, Ghermez- e- Naishabur, Sourati- e- Kurdistan, Eghlid, Meshkan, Dorcheh- e- Esfahan, Gholighese- e- Zanjan, Shenat, Tarom and Kazebar". The seeds were sown in the cold frame in the last week of February. The seedlings were transplanted to the field on April and were spaced 10 cm in rows, 2.5 m long and 60 cm apart. The experimental design was randomized complete block design with three replications. The trial consisted of 15 treatments each plot contained four rows and eighty plants. The experiment was done in two years (2003 & 04). No pesticide was applied in the plots during the experiment through out the season. The irrigation was done every three days and weeds were removed three times with hand. The number of thrips was counted two times (60 & 75 days after planting). The thrips count was based on the population of thrips in five plants selected at random in each plot. Also the sign of thrips damage was evaluated from five plants of each plot, which scale for this trait was 2 - 5 (1 - 10% = 2, 10 - 25% = 3, 25 - 50% = 4, more than 50% = 5) (Smith *et al*., 1994). The angle divergence of the two innermost leaves was measured by conveyor (A.W. Faber, Germany). Quantity of leaf wax was determined by immersing 100 g un-damaged fresh leaves in chloroform for 30 seconds (Stadler & Buser, 1984). Leaf temperature was measured by digital thermometer (Minitemp, Raytek Corporation, China) at 14 pm. pH of leaf was measured by pH meter (Metrohm 744, Swiss). Quantity of potassium was determined by atomic absorbtion spectrophotometer (AOAC, 1990) and phosphoric acid was determined by spectrophotometric method (Jeffery *et al.*, 1989). Analysis of variance of data was done by SPSS 13.0. The Pearson correlation was done between traits thrips number, leaf infestation and leaf wax.

RESULTS

The 15 Iranian onion genotypes had different leaf color, leaf cross- section and leaf erectness (Table I). Results revealed that all genotypes were divided in three groups, based on leaf color (Table I). Genotypes "Sefid- e- Kurdistan", "Sefid- e- Qom", "Meshkan" and "Eghlid" had light green color (glossy foliage) and these genotypes had circular leaf cross section and prostrate leaf (Table I).

Analysis of variance showed that mean thrips number per plant was significantly different between genotypes (Table II). The lowest and the highest thrips number were counted in genotypes "Meshkan" and "Sourati- e- Kurdistan" respectively (Table II). Other genotypes had intermediate thrips number per plant. The percentage of leaf infestation was highly significant and genotypes "Meshkan", "Sefid- e- Qom" and "Sefid- e- Kurdistan" showed the lowest leaf infestation percentage (data not shown). The genotype "Sourati- e- Kurdistan" showed the highest leaf infestation. The angle divergence of the two innermost leaves showed significant difference ($P < 0.01$) level and the largest leaf angle was belong to genotypes "Sefid- e- Kurdistan", "Sefid- e- Qom", "Meshkan" and "Eghlid". Quantity of leaf wax showed significant difference between genotypes and lowest leaf wax content was measured in genotypes "Meshkan" and "Eghlid". Genotypes "Sefid- e- Kurdistan "and "Sefid- e- Qom" were placed in the second group (Table III).

Although leaf temperature of glossy foliage genotypes, "Sefid- e- Kurdistan", "Sefid- e- Qom", "Meshkan" and Eghlid" was lower than dark green genotypes, but this difference was not significant ($P < 0.05$). Genotypes did not considerable difference for leaf pH and ratio of potash to phosphoric acid. Percentage of bulb dry matter showed significant difference and genotype "Meshkan" with glossy foliage had the highest while "Sourati- e- Kurdistan" with non-glossy foliage the lowest bulb dry matter (Table IV).

The Pearson correlation between traits: thrips number, leaf infestation and leaf wax showed that there was a highly positive significant correlation between thrips number and leaf infestation and negative correlation between thrips number and leaf wax content (Table V).

DISCUSSION

The resistance of the "White Iranian" onions ("Meshkan", "Sefid- e- Kurdistan", "Sefid- e- Qom" & "Eghlid") to thrips seems to be determined by two factors: firstly it controls those characters that hold the thrips population to a minimum and secondly it helps the plant to withstand injury. Two or perhaps three characters apparently tend to restrict the thrips population: the shape of the leaves, the angle of divergence of two innermost leaves and the distance apart of leaf blades on the sheath column. Considerable importance is the difference in shape of the leaves. The genotypes with glossy foliage had lower thrips number per plant and percentage of damage sign than non-glossy foliage genotypes. In most genotypes (especially in "Sourati- e- Kurdistan") the leaf blades had flat side. These sides are face to face and closely appressed in young leaves, protecting the thrips larvae against insect enemies and adverse weather conditions. In glossy foliage genotypes the leaves are almost circular in cross section, reducing protection to a minimum.

A wide angle between two innermost emerged leaves, especially in the young plant, is another character of glossy foliage genotypes that help to restrict the thrips population by reducing the protective environment to a minimum. Still, another character, probably of some importance, is greater vertical distance between the leaf blades. Each new leaf extends its sheath farther beyond the one encircling it than in other commonly cultivated varieties. This habit of growth produces an extremely long sheath column.

Table I. Leaf characteristics of 15 Iranian onion genotypes

Genotypes	Leaf color	Leaf cross section	Leaf erectness
Sefid- e- Qom	light green	circular	prostrate
Meshkan	light green	circular	prostrate
Eghlid	light green	circular	prostrate
Sefid- e- Kurdistan	light green	circular	prostrate
Sefid- e- Kashan	medium	semi-circular	erect
Tarom	medium	semi-circular	erect
Dorcheh- e- Esfahan	medium	three-angle	erect
Kazebar	dark green	three-angle	erect
Ghermez- e- Azarshahr	dark green	semi-circular	erect
Sefid- e- Khomein	dark green	semi-circular	erect
Gholigheseh- e- Zanjan	dark green	semi-circular	erect
Sourati- e- Kurdistan	dark green	semi-circular	erect
Sefid- e- Naishabur	dark green	semi-circular	erect
Ghermez- e- Naishabur	dark green	semi-circular	erect
Shenat	dark green	semi-circular	erect

Table II. Mean thrips number of 15 Iranian onion genotypes [Duncan's multiple range test at 5% level with standard deviation (S.D.)]

Genotypes	Thrips Number ± S.D.	
Meshkan	09.5	± 1.0 g
Sefid- e- Kurdistan	12.3	± 2.9 fg
Sefid- e- Qom	18.2	± 5.2 efg
Sefid- e- Naishabur	18.6	± 0.6 ef
Eghlid	24.6	± 5.4 efg
Sefid- e- Kashan	24.6	± 2.4 ef
Shenat	25.0	± 3.4 ef
Sefid- e- Khomein	30.6	± 6.3 de
Tarom	34.6	± 4.0 cd
Ghermez- e- Azarshahr	34.6	± 1.3 de
Dorcheh- e- Esfahan	35.3	± 2.4 cd
Kazebar	39.1	± 1.6 cd
Ghermez- e- Naishabur	42.6	± 9.6 bc
Gholigheseh- e- Zanjan	54.6	± 4.8 ab
Sourati- e- Kurdistan	67.3	± 7.0 a

Different letters in the columns indicate statistically significant differences

Table III. Mean quantity leaf wax of 15 Iranian onion genotypes [Duncan's multiple range test at 5% level with standard deviation (S.D.)]

Genotypes	Leaf wax ± S.D. (mg/100 g fresh weight)	
Eghlid	0.0020	± 0.0020 d
Meshkan	0.0050	± 0.0015 d
Sefid- e- Kurdistan	0.0070	± 0.0010 cd
Sefid- e- Qom	0.0072	± 0.0008 cd
Kazebar	0.0070	± 0.0006 cd
Dorcheh- e- Esfahan	0.1320	± 0.0060 bcd
Sefid- e- Naishabur	0.0130	± 0.0007 bcd
Tarom	0.0140	± 0.0001 bcd
Sefid- e- Kashan	0.0142	± 0.0006 bc
Shenat	0.0142	± 0.0003 bc
Gholigheseh- e- Zanjan	0.0200	± 0.0030 b
Ghermez- e- Azarshahr	0.0190	± 0.0020 b
Sefid- e- Khomein	0.0200	± 0.0030 ab
Sourati- e- Kurdistan	0.0270	± 0.0080 a
Ghermez- e- Naishabur	0.0270	± 0.0020 a

Different letters in the columns indicate statistically significant differences

Genotypes with glossy foliage were resistant to thrips and leaf wax of these genotypes, were lower than susceptible ones. Several studies indicated that resistant onion populations had lower leaf wax content than susceptible ones (Hemmati & Benedictus, 2000; Nouri Moghaddam *et al.,* 2004). Thrips injury becomes most conspicuous following the first hot days of summer when there is a desiccation and dying back of the foliage. However, it is not known how high temperatures accentuate thrips injury. This typical injury is most prominent in genotypes with dark green foliage (non-glossy foliage) and is apparently absent in glossy foliage genotypes.

Leaf color is a main factor in resistance to thrips injury, because the temperature in leaf tissues of glossy foliage genotypes is lower than genotypes having darker green foliage. Similarly, in the tomato fruit, dark green areas were more prone to injury by sunscald than light green areas, because of the greater absorption of light with a consequent higher temperature in these areas (Harvey, 1924).

Although Comes (1917) and Monzen (1926) stated that pH of plant sap or acidity of plant sap in resistant apple stock is higher than susceptible, but we could not find any relationship between pH of leaf sap and resistance to thrips. Ratio of potash to phosphoric acid did not show any difference in resistant and susceptible genotypes. It was on the contrast of result of Andrews (1921).

Table IV. Mean bulb dry matter of 15 Iranian onion genotypes [Duncan's multiple range test at 5% level with standard deviation (S.D.)]

Genotypes	Bulb dry matter (%) ± S.D.
Meshkan	15.50 ± 1.30 a
Sefid- e- Qom	13.50 ± 1.40 ab
Sefid- e- Kurdistan	12.90 ± 1.40 ab
Ghermez- e- Naishabur	12.20 ±1.40 ab
Eghlid	11.70 ± 0.80 bc
Shenat	11.50 ± 0.30 bc
Sefid- e- Kashan	11.20 ± 1.10 bc
Gholigheseh- e- Zanjan	11.06 ± 0.40 bc
Kazebar	11.05 ± 0.90 bc
Sefid- e- Khomein	10.90 ± 0.40 bc
Sefid- e- Naishabur	10.70 ± 0.10 bc
Dorcheh- e- Esfahan	10.60 ± 0.40 bc
Ghermez- e- Azarshahr	10.40 ± 0.40 bc
Tarom	10.30 ± 0.50 bc
Sourati- e- Kurdistan	08.40 ± 0.60 c

Different letters in the columns indicate statistically significant differences.

Table V. The Pearson correlation between thrips number, leaf infestation and leaf wax content of 15 Iranian onion genotypes

	Thrips No.	Leaf infestation (%)	Leaf wax (mg/100 g fresh weight)
Thrips no	-	0.75**	0.76**
Leaf infestation (%)	0.75**	-	0.78**
Leaf wax (mg/ 100 gfw)	0.78**	0.78**	-

**: Significant difference at 1% level

Glossy foliage genotypes had higher bulb dry matter percentage than susceptibles, although we could not find any difference between leaf dry matter percentage of glossy and non-glossy foliage genotypes.

Finally, further research should analyze the leaf waxes extracted from resistant and susceptible genotypes for determining the chemistry of leaf waxes. Also, evaluation other Iranian genotypes for resistance to thrips and measuring other important traits that may related to resistance to thrips should be study in detail.

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