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Effects of grafting on fruit's quality in two tomato cultivars (*Lycopersicon esculentum* Mill.) grown in hot bed

Javid Emaratpardaz[*1], Fahimeh Bagheri[2], Jaber Panahande[2], Zahra Eslaminezhad[2] , Habib Davati-Kazemnia[2]

[1]*Department of Plant Eco-physiology, Faculty of Agriculture, University of Tabriz, Tabriz, Iran*

[2]*Department of Horticultural Sciences, Faculty of Agriculture, University of Tabriz, Tabriz, Iran*

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Abstract

Tomato (*Lycopersicon esculentum* Mill.) is a crop of high economic importance in many countries. The cultivation of grafted fruit bearing vegetable plants has increased greatly and grafting is an important technique for the sustainable production of fruit bearing vegetables in Iran and some Asian and European countries, where land use is very intensive and continuous cropping is common. The influence of different grafting methods on the success of grafting and fruit yield of two tomato cultivars (Es10002 and Heirloom) was studied in a hydroponic hot bed system The results of experiment showed that, grafting was effective on some of qualitative properties. Among these properties, could refer to pH, EC, vitamin c, dry weight and shelf life of fruit , which these ones also influenced by both stock and scions. The results showed that grafting didn't have significant influence on fresh weight of fruit but for dry weight of fruit showed significant different. The results of this research showed that grafting had significant influence on potassium rate of fruit. The comparison of means showed that self-grafting treatments of variety ES10002 and heirloom had highest and lowest potassium level respectively, but grafting didn't have significant influence on phosphor level of fruit. Grafting is thus considered an important technique for sustainable greenhouse production of fruit-bearing vegetables.

* **Corresponding Author:** Javid Emaratpardaz ✉ emarat@tabrizu.ac.ir

Introduction

Tomato is one of the most important world fruit vegetables which is native of Peru in South American (Kinet and Peet, 1997). This plant has been brought in the middle of sixteen century from South American to Europe and used for fresh consumption and production commercially (Everett, 1984). This vegetable is one of the rich sources for several vitamins, folic acid, lycopene and antioxidant components (Rubatzky, 1996). Production of tomato is difficult to grow during hot-wet season, flooding, waterlogged soils, and high temperature can significantly reduce yields. In order to solve these problems the modern production techniques such as hot beds and plastic tunnels has been increased considerably. Among other mechanism grafting is one of the best ways to solve some of the abovementioned problems existed in tomato. Therefore grafting can minimize problems caused by flooding, soils and diseases and play a great role in increasing yield and quality and helps to provide tolerance to variety of biotic stresses such as resistance against soil born diseases (Besri, 2003) and abiotic stress such as salinity, drought, high temperature, low temperature and inadequate humidity (Rivard and Louws, 2006). Grafting in Vegetables was originated in South Asia, Chinese, Korea and Japan. In fifteen and sixteen centuries grafting has been used for propagation of plants which mainly related to *Cucurbitaceae* and *Solanaceae* family and the major vegetables crops being grafted are: tomato, cucumber, melon, eggplant, watermelon and pepper. The cultivation of grafted vegetable plants began in Korea and Japan at the end of the 1920s when watermelon plants were grafted onto squash rootstock (Lee, 1994; Lee and Oda ,2003). In our time , grafting is applied as a ordinary , 90 to100 % in water melon , 5 to10 % in cucumber, 2 to 3 % in tomato and eggplant (Traka *et al*, 2000). There are several varieties of methods for grafting vegetable crops that Tube grafting and mostly cleft grafting is used in tomatos which both have desirable results (Oda, 1999). Generally, different parameters have influence on quality of fruits. Among these parameters could refer to genetic of plants, environmental factors and arable farming factors such as organic nutriment, pH and EC of nutrition solution (Chapagain and Wiesman 2004). In vegetable crops, grafting has been used for confront with biotic and a biotic stresses and rarely (Khahe *et al*, 2006). There are many reports about quality change of fruits in consequence of grafting (Daris *et al.* 2008) but the effect of grafting on quality of fruits is not clear completely (Besri, 2003; Trionfetti *et al.* 2002) . These produced diversities in quality of fruit could be relating difference in cultural environment or type of applied stock or interaction stock and scion (Davis *et al*, 2008). Huang *et al* (2009) reported that grafting of cucumber on a stock resistant against salinity under salinity stress conditions , increases the dry mater rate, glucose rate of fruit and titratable acidity, but don't has effect on vitamin C content. In melon the effect of grafting on quality of fruit in respect of crispness of fruit flesh has been studied which there was significant improvement in quality of fruit (Bletsos, 2005; Roberts *et al.* 2005; Davis *et al.* 2008).

The main aim of this research was to study effect of grafting on two varieties of tomato, Es 10002 and heirloom, because of their dedicated culture land importance and tried to determine qualitative responses of considered varieties to different grafted compounds in hot bed and controlled conditions and showed the influence of stock on assimilation and distribution of some necessary elements.

Materials and methods

Plant material

This experiment has been conducted in hydroponic hot bed system at faculty of agriculture, university of Tabriz during 2009-2010. The applied bed in primary stages of culture, for plants germination was mixture of Peat and perlite by rate 2:1 which transfer in plug trays. The main applied bed for maintenance and growth of plants was mixture of fine and medium grain perlite which after preparing, this bed transferred into plastic pots with height of 30cm and mouth diameter of 20 cm. in this experiment, was used one hot bed hybrid tomato type (Es10002 F1) with suitable quality and growing properties and a

variety of open pollinated indeterminate heirloom tomato (h1) with pleasant flavor and aqueous fruit. The cleft grafting was conducted on young seedling after one month of plants culture, after grafting, the young seedlings because of slickness of textures and rapid evaporation of them has been set in healing room with humidity of 80 to 90 percent and temperature of 25 C for increasing of receptively. Approximately, 12 days after of grafting, all seedling was converted to a pot and irrigated in this test, the direction of plants was conducted vertically and Uni-branch. The name of treatment was shown in below: Es10002 (E), Es10002 grafted on Es10002 (E+E), Es10002grafted on Heirloom (E+H), Heirloom (H), Heirloom grafted on Heirloom (H+H), Heirloom grafted on Es10002 (H+E).

Fruit quality measurements

The total soluble solids (TSS) have been measured by refractometer. In order to measure of EC and pH, 2 ml of fruit juice was diluted with distilled water to a ratio of 1 to 10. Then pH meter pH and EC meter was used for measure those factors. Vitamin C, measured by titration methods mentioned compounds were used with dye D- Dichlorophenolindophenol (McMurray and *et al*, 1980).

To determine the shelf life of each treatment, fruits were harvested in the tight red and in the germinator was placed at 1 ± 10 ° C, Shrinkage and loss of firmness of fruits were harvested after the end of life. Plant extracts phosphorus concentrations were measured using Vanadomolybdophosphoric acid method (Olsen and Sommers, 1982). The quantity of Calcium measured by atomic absorption spectrophotometry (Waling and *et al,* 1989).

Data analysis

The experiment was arranged as complete plots on the basis of completely randomized design with three replications. Analysis of variance (ANOVA) carried out with SPSS software. The significance of the differences among treatments was tested by applying a one-way ANOVA, at a confidence level of 95%.

Results and discussion

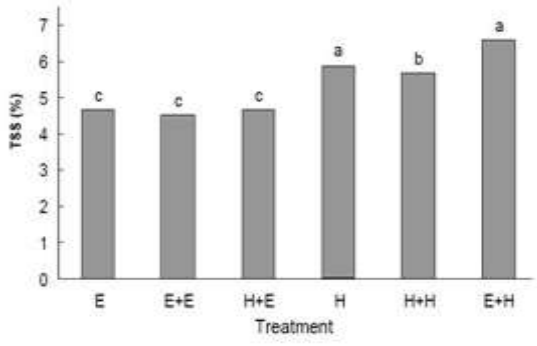
The results showed that grafting didn't have significant influence on fresh weight of fruit but for dry weight of fruit showed significant different. The comparison of means (table 1) showed that cultivar of heirloom grafted on Es10002 stock and non-grafted variety Es10002 have a maximum and minimum dry weight of fruit, respectively and there isn't significant difference between all treatments. Khahe and *et al* (2001) reported that grafting doesn't have significant influence on dry and fresh weigh of fruit in hotbed culture and open air conditions, according the previous result, present results showed that grafting could increase the total soluble solid (TSS) of fruit. According to table 1, the heirloom grafted on Es10002 stock has been highest level of EC and pH amount and the non-grafting Es10002 has been lowest level of pH and Es10002 grafted on heirloom stock has minimum EC there was significant effect of grafting on total soluble solid. The cultivar of heirloom grafted on Es10002 stock and self- grafting compound of Es10002 have minimum and maximum soluble solid rate respectively and there isn't considerable different among other treatments and self- grafting treatment has less soluble solid them non- grafting cultivars (Fig. 1). Balliu and *et al* (2007) showed that, soluble solid rate in grafted plants of tomato is higher than not grafting plants, it seems that different genotype of used stock and scion in addition, other researchers also reported that influence of grafting on soluble solid rate of fruit which is one of quality properties of fruit, isn't clear precisely (Leoni, 1990; Romano, 2001). These results are comparable with results of Zhilong (2007) which showed that, there was significant effect of grafting on soluble solid rate of fruit. Grafting has significant influence on vitamin C rate of fruit, self- grafting treatments had higher vitamin C rate than non- grafting treatments. In fact, cultivar heirloom has higher vitamin C rate and treatments which have stake or scion of heirloom, have higher vitamin C than non- grafting Es10002 and self- grafting treatment. These results are comparable with findings of Balliu and *et al* (2007) which reported higher vitamin c rate in grafting plants than non- grafting ones. Grafting has

significant influence on probability level of percent on shelf-life of fruits while half of fruits and also while total of fruits lose their self life. The comparison of means showed that (Fig. 2) self-grafting treatments have higher shelf life than non-grafting varieties this fact might be because of increased assimilation of calcium and day matter of fruit and it seems that decreased assimilation of nitrate by fruit tissues .Based on results of Kotsiras and *et al.* (2002) the postharvest shelf life of cucumber has positive significant correlation which calcium content , and based on Montanaro and *et al.* (2006), cellular wall has influence of shelf life as well as increased assimilation of ammonium causes to decreased assimilation of calcium and result decreased post-harvest shelf life. The results (table1) showed that ES10002 grafting on stock of heirloom and self grafting ES10002 had maximum and minimum calcium content respectively. The results of this research showed that grafting had significant influence on potassium rate of fruit. The comparison of means (table1) showed that self-grafting treatments of variety ES10002 and heirloom had highest and lowest potassium level respectively but Grafting didn't have significant influence on phosphor level of fruit. In contrast with Leonardi and Giuffrida (2006) and Ruiz and *Et al* (1997) who indicated that, absorption of phosphor increases in consequence of grafting, in this experiment there wasn't considerable different between phosphor assimilation of grafting plants and non grafting ones (table 1). It seems that, grafting couldn't have influence on assimilation rate of phosphor.

Table 1. Effect of grafting on fruit quality in two cultivars of tomato.

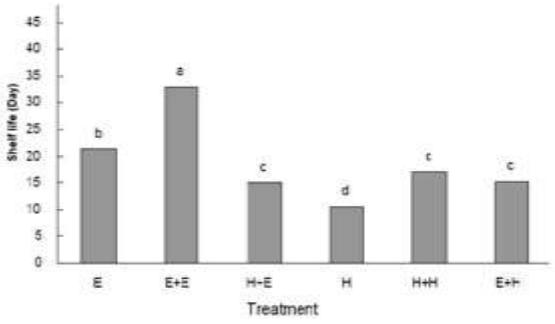
Treatmens	Ca^{++} $mgkg^{-1}$ (DW)	K^{+} $mgkg^{-1}$ (DW)	P $mgkg^{-1}$ (DW)	Vitamin C $mgkg^{-1}$ (FW)	pH	EC $^{q}scm-1$	Fruit DW g	Fruit FW g
E	4.52c	509.66d	4.213c	83.193a	4.52c	509.66d	4.213c	83.193a
E+E	4.710a	536.33cd	4.85bc	91.556a	4.710a	536.3cd	4.85bc	91.556a
H+E	4.53c	450d	4.84bc	90.63a	4.53c	450e	4.86bc	90.633a
H	4.75a	559.66c	6.86b	117.75a	4.75a	559.86/c	6.84b	117.756a
H+H	4.61b	635.66b	5.74bc	94.936a	4.61b	635.56b	5.74bc	94.936a
E+H	4.76a	697.65a	9.19a	141.340a	4.76a	697.68a	9.19a	141.340a

* Values carrying different letters are significantly different at P ≤0.05.



* Values carrying different letters are significantly different at P ≤0.05.

Fig. 1. Effect of grafting on TSS in two cultivars of tomato.



* Values carrying different letters are significantly different at P ≤0.05.

Fig. 2. Effect of grafting on Shelf life in two cultivars of tomato.

In summary; the results of experiment showed that, grafting was effective on some of qualitative properties. Among these properties , could refer to pH, EC, vitamin c, dry weight and shelf life of fruit , which these ones also influenced by both stock and scions . Mainly stock of ES10002 and scion heirloom has operated better. In this research, there was significant effect of grafting on assimilation rate of calcium and potassium in tomato, but treatment was different in respect of assimilation of elements in fruit, self-grafting compound of ES10002 and grafting compound of ES10002 grafting on stock of heirloom had highest level of potassium and calcium respectively. In the case of potassium assimilation in fruit both stock and scion had significant effect and stock and scion of ES10002 in this property have operated better. However, grafting didn't have significant influence on assimilation rate of phosphor in fruit.

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