Scientific Papers. Series B, Horticulture. Vol. LXV, No. 1, 2021
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

IDENTIFICATION OF SOME ROOTSTOCKS FOR TOMATO CULTURES FROM ROMANIA

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Abstract

The research was conducted at the Horting Institute - Bucharest, on a grafted and non-grafted tomato collection cultivated in a greenhouse. The Solanum lycopersicon cultivars used to obtain of grafted seedlings were the Abellus F1 Alamina F1 and Siriana F1 hybrid scions and the Emperador F1, He Man F1 and L568 rootstocks. The biometric measurements on the fruit yield were made in 2020 year. The experience were aimed the identification of some rootstocks for the tomato cultures from Romania. The research show that the rootstocks has influenced the fruit yield and some grafting combinations researched may be recommended for the cropping in Romania.

Key words*: grafted culture, rootstock, scion, Solanum lycopersicon, yield.*

INTRODUCTION

Tomatoes are valuable vegetables, with the highest share of Romanian crops in protected spaces (Sora et al., 2019). Tomato (*Solanum lycopersicum* L.) is one of the most popular vegetable crops in the world and the grafting on the *Solanaceae* is a similar approach to crop rotation (Sora et al., 2020).

Tomato is one of the most economically important vegetables in the world. Grafting in tomato has grown for various purposes including the increase of yield. An alternative use of native tomato genotypes is as rootstocks for grafting improved tomato (Velasco-Alvarado et al., 2017).

Abd El-Wanis et al., 2013, show that among the objectives of grafting are plant growth, yield and fruit quality.

Tomato grafting is becoming a well-developed practice worldwide with many horticultural advantages. The primary motivation for grafting tomato has been to prevent the damage caused by the soilborne pathogens under the intensive production system. However, recent reports suggest that grafting onto suitable rootstocks can also alleviate the adverse effects of abiotic stresses. This review gives an overview of the scientific literatures on the various aspects of tomato grafting including important steps of grafting, grafting methods, scion–rootstock interaction, and rootstock-derived changes in vegetative growth, fruit yield, and quality in grafted plants under different growing conditions (Singh et al., 2017).

Velasco-Alvarado et al., 2017, show that some grafted tomatoes used in the study (27,000 plants/ha) had a significant increase in yield up to 54 t/ha. They believe that tomato grafting has developed for various purposes, including to increase yield, and have researched some tomato cultivars as rootstocks to identify of some remarkable genotypes for their potential in tomato production.

Gelan and Waraka, 2019, have shown that the yield of tomatoes can increase up to 98.3% by grafting.

The results concerning the grafting influence on vegetable crops require more researches in this domain for to highlight the grafting effect on the some aspects regarding the grafted vegetable production.

This research were aimed the identification of some rootstocks which positively influences fruit yield in the tomato cultures from Romania.
Research concerning the influence of rootstocks on the quantitative and qualitative properties of tomatoes is an important research activity at ICDIMPH - Horting Bucharest.
Here, the research activity in the domain of the tomato grafting started since 2000 year.

MATERIALS AND METHODS

The experience has been realized at the Horting Institute in some vegetable greenhouses.
The vegetal material used in experience has consisted from tomato scions and rootstocks commonly used in Romania for tomato grafting.
The scions were tomato F1 hybrids, Alamina, Abellus (Rijk Zwaan, US) and Siriana (Vegetable Research and Development Station Buzău, Romania). The rootstocks were tomato F1 hybrids, Emperador (Rijk Zwaan, US) He Man (Syngenta, Switzerland), L685 (Vegetable Research and Development Station Buzău, Romania).
The non-grafted and grafted tomato seedlings have been obtained into a specialized greenhouse for research & production of grafted seedlings.
The non-grafted and grafted tomato plants had been cultivated on soil into a glass greenhouse for vegetable production.
The research variants were made up from lots of non-grafted (control) and grafted tomatoes:

- non-grafted plants (control):
  - Alamina
  - Siriana
  - Abellus
- grafted plants (scion x rootstock):
  - Alamina x Emperador,
  - Alamina x L685,
  - Alamina x He Man,
  - Siriana x Emperador,
  - Siriana x L685,
  - Siriana x He Man,
  - Abellus x Emperador,
  - Abellus x L685,
  - Abellus x He Man,

All the scion F1 hybrids are indeterminate tomatoes with spherical and red fruit and a weight more than 150 g/fruit.

The experimental lots with non-grafted and grafted tomatoes were set up at May 6, 2020 (Figure 1).

a) planting day

b) vegetative period

c) harvest period

Figure 1. Experimental lots with grafted tomatoes Horting Institute

The experience with 27,000 non-grafted tomatoes/ha and 18,000 grafted tomatoes/ha) was made up by the randomized block method: 12 variants (90 plants/variant) with 3 repetions (30 plants/repetion). The soil from greenhouse where the experiment was created has had the chemical and organic characteristics listed in the Table 1.

Table 1. Chemical and organic characteristics of soil

Analyze	Resultat	MU	Interpretation
pH (20±2°C)	8.04	-	
EC (25±1°C)	0.475	mS/cm	
CATIONI			
N-NH_4 (λ=660 nm)	12.1	mg/kg	
K (λ=766.490 nm)	32.9	mg/kg	
Na (λ=589.592 nm)	117.3	mg/kg	
Ca (λ=317.933 nm)	186.4	mg/kg	
Mg (λ=279.077 nm)	65.1	mg/kg	
ANIONI			
N-NO_2^- + N-NO_3^- (λ=540 nm)	163.4	mg/kg	
Cl^- (λ=470 nm)	123.1	mg/kg	
SO_4^{2-} (λ=420 nm)	144.9	mg/kg	
P (λ=213.617 nm)	218.0	mg/kg	
MICROELEMENTS			
Fe (λ=238.204 nm)	19.6	mg/kg	
Mn (λ=257.610 nm)	8.2	mg/kg	
Zn (λ=213.857 nm)	10.4	mg/kg	
B (λ=249.677 nm)	0.3	mg/kg	
Cu (λ=327.393 nm)	22.5	mg/kg	
HUMUS	2.48	%	

MU – measure unit | big | medium | small |

The fertilization program used in experience: at soil preparation was administered Complex 16–16-16 (300 kg/ha) and then (kg/100 m^2/day), as follows:

- *the 5th day after planting - the 15th day:* 0.1 kg potassium sulphate + 0.1 kg ammonium nitrate,
- *the 16th day - the 25th day:* 0.15 kg potassium sulphate + 0.1 kg ammonium nitrate,
- *the 26th day zi - the 35th day* 0.05 kg GL fruit 18-11-59 + microelements + 0.05 kg azotat amoniu,
- *the 36th day - the 45th day:* 0.1 kg GL fruit 18-11-59 + microelements,
- *the 46th day - the 55th day*: 0.1 kg potassium sulphate + 0.1 kg ammonium nitrate,
- *the 56th day - the 60th day*: 0.1 kg potassium sulphate,
- *in vegetation, at 10 days intervals*: 4 treatments with Folimax 0.3%.

The Delta-T meteorological station with sensors for temperature, atmospheric humidity, precipitations and solar radiation was used for the monitorizing of climatic factors, programmed to record the climatic data at one hour intervals; its there are in the Table 2.

Table 2. Climatic data from greenhouse (May - August, 2020)

Month	Temperature (°C)			Atmospheric humidity (%)			Soil temperature (°C)	Soil humidity (%)
	minimum	maximum	average	minimum	maximum	average		
May	15.6	31.7	20.9	30.1	68.5	50.7	20.2	39.1
June	14.9	39.2	25.5	28.1	86.3	61.3	21.4	30.8
July	16.5	40.5	27.3	25.6	85.2	53.3	22.1	40.7
August	16.2	40.1	27.4	22.5	81.8	49.4	25.1	50.6

The Observations and the biometric determinations on the tomato fruits were performed in the research laboratory of the Horting Institute on biological samples harvested at the consumption maturity.

The statistical calculation consisted in the processing of results using the Duncan test (p = 5%). The regression equations and the correlation coefficients were been calculated through the analysis of variance (ANOVA) for

highlighting a correlation between production per plant and per hectare for working variants.

RESULTS AND DISCUSSIONS

It was observed that rootstocks have influenced precocity. Thus, the non-grafted plants in the all researched variants were earlier (July 15 - first harvest) comparative to the grafted plants (July 20 - first harvest). The difference consisted in 5 days between the first harvest of non-grafted variants and the first harvest of grafted variants. In a study on grafted and non-grafted tomatoes, researchers Peil and Gálvez, 2004, have showed that the rootstocks had a negative effect on the precocity, but did not affect the total fruit production.

There were differences on the tomato production in the experimental variants.

The fruit yield per plant obtained in this research is shown in the Table 3; the results are presented as an average/variant.

Table 3. Fruit yield on tomato variants

Variants	Number of fruit/plant	Average weight/fruit (kg)	Production/plant (kg)
Alamina (control)	9.66	0.175	1.69
Alamina x Emperador	9.4	0.184	1.73
Alamina x L685	9.43	0.175	1.65
Alamina x He Man	9.57	0.184	1.76
Siriana (control)	7.93	0.145	1.15
Siriana x Emperador	8.14	0.156	1.27
Siriana x L685	7.4	0.15	1.11
Siriana x He Man	8.18	0.159	1.3
Abellus	10.3	0.165	1.7
Abellus x Emperador	11.64	0.165	1.92
Abellus x L685	10.58	0.155	1.64
Abellus x He Man	11.86	0.167	1.98

The fruit numbers per plant had been relatively similar between the control and grafted plants conducted in the all 3 tomato hybrids, Alamina (9.66/control plants comparative with 9.4-9.57/grafted plants); Siriana (7.93/control plants comparative with 7.4-8.18/grafted plants), Alamina (10.3/control plants comparative with 10.58-11.86/grafted plants).

There were differences between variants at average weight per fruit: the He Man rootstock has influenced most positively this production parameter, in all grafting combinations it had fruits with the highest weight (159-184 g/fruit) compared to the fruits from the plants grafted on the Emperador rootstock (156-184 g/fruit), the control plants (145-175 g/fruit) and those grafted on the L685 rootstock (150-175 g/fruit). There were small differences between the control variants and the grafted variants at the average weight per fruit (0-0.009 kg for Alamina, -0.005-0.014 kg for Siriana and -0.010-0.002 kg for Abellus); the He Man rootstock had had the most positive influence on this production parameter.

Total production per plant was positively influenced by the Emperador and He Man rootstocks and negatively by the L685 rootstock; there were significant differences.

At all grafting combinations, the fruit yield per hectare had been negative comparative with control plants because the planting had been made with 18,000 grafted plants/ha and 27,000 non-grafted plants/ha (Table 4).

Table 4. Fruit yield per hectare

Variants	Production (t/ha)	Diferența (%)
Alamina	45.63 a	100
Alamina x Emperador	31.14 c	-14.59
Alamina x L685	29.7 d	-16.03
Alamina x He Man	31.68 b	-14.05
Siriana	31.05 a	100
Siriana x Emperador	22.86 c	-8.08
Siriana x L685	19.98 d	-10.96
Siriana x He Man	23.4 b	-7.54
Abellus	45.9 a	100
Abellus x Emperador	34.56 c	-11.26
Abellus x L685	29.52 d	-16.3
Abellus x He Man	35.64 b	-10.18

a, b, c, d - significant differences (Duncan test, p = 5%).

The total production per at the non-grafted plants was 45.9 t/ha (Abellus), 45.63 t/ha (Alamina), 31.05 t/ha (Siriana), between 23.4 – 35.64 t/ha by grafting on the He Man rootstock, 22.84-34.56 t/ha by grafting on the Emperador rootstock and 19.98-29.7 t/ha by grafting on the L685 rootstock. The production differences from the control were 14.05-16.03% (Alamina), 10.18-16.3% (Abellus) and 7.54-10.96% (L685).

Milles et al., 2016, found that at some genotypic combinations (Rita variety grafted on the ES 99-265, Line 9242, PG 99, Robusta rootstocks) obtained an equal yield with the yield of the non-grafted variety and some rootstocks produced a lower yield (Energy, Firefly, Line 9243, Nico) and others produced a higher yield (Beaufort, He-Man, Joint, P1614, RS 1427).

Researchers Severino et al., 2017, showed that the yield increased from 81 to 103 t/ha comparing the lowest (20,000) and the highest (29,000) stem density/ha, but the difference between the systems was only 4 t/ha.

Doltu et al.2019, have obtained at the Siriana tomatoes grafted on the Emperador rootstock (20,000 plants/ha) a fruit production per plant more with 54.76% and a production per hectare more with 14.64% comparative to the non-grafted Siriana tomatoes.

The grafting researchers have experimented and they recommend different planting densities for the cultivation of some grafted tomatoes:

- 10,000 plants/ha (Torres et al., 2015),
- 12,500-15,000 plants/ha (5,060-6,070 plants/acre) (Milles and et al., 2016),
- 12,800 plants/ha (Khah et al., 2006),
- 15,000 plants/ha (Bogoescu et al., 2011),
- 20,000 plants/ha (Doltu et al., 2019)
- 26,000 plants/ha (Mohammed et al., 2009),
- 27,000 plants/ha (Velasco-Alvarado et al., 2017).

The indirect linear correlations were obtained between production per plant and per hectare for all grafting combinations.

The value of determination coefficients shows that at production per hectare, the significance of the correlation is distinctly significant (r^2 = 0.5639; r^2 = 0.4071; r^2 = 0.4532) (Figures 2, 3 and 4).

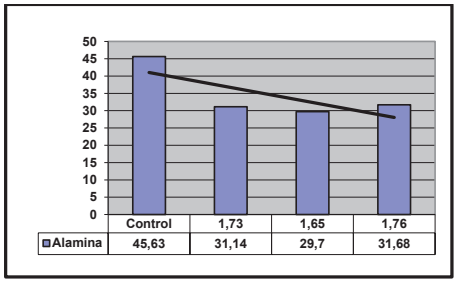

Figure 2. Indirect and distinctly significant linear correlation at Alamina tomatoes

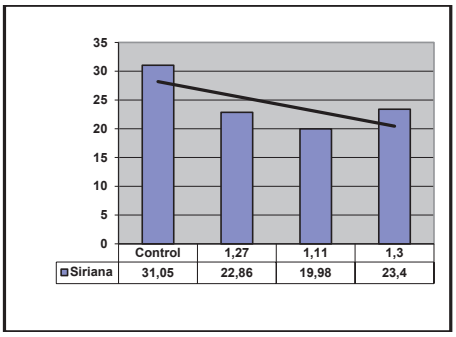

Figure 3. Indirect and distinctly significant linear correlation at Siriana tomatoes

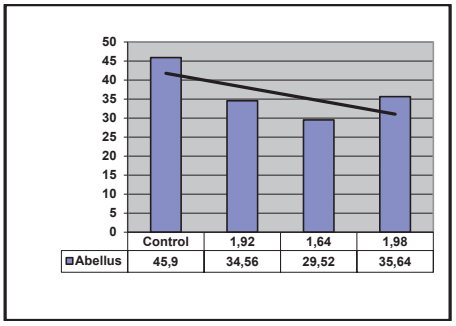

Figure 4. Indirect and distinctly significant linear correlation at Abellus tomatoes

CONCLUSIONS

The rootstock has influenced the fruit production per plant; He Man and Emperador rootstocks had have a higher production and L685 rootstock has have a lower production compared to the control plants.

The plant densities have influenced the fruit production per hectare: the non-grafted tomatoes (27,000 plants/ha) had a bigger production comparative to the grafted tomatoes (18,000 plants/ha); there were significant differences.

Indirect linear and distinctly significant correlations were obtained between production per plant and per hectare for all grafting combinations due to planting density.

The use grafted Alamina, Siriana, Abellus tomatoes, the grafting combinations (scions x rootstocks) researched in this paper, may be recommended for growing in Romania.

Based on these results, it can be said that rootstocks played an important role in fruit production and the use of other planting densities is recommended (20,000-27,000

plants/ha) or other culture systems (2-3-4 stems/plants).

The results showed that grafting on the appropriate rootstocks (He Man, Emperador) has positive effects on fruit production per plant compared to non-grafted tomatoes and tomatoes grafted on other rootstock (L685).

ACKNOWLEDGEMENTS

This research was conducted within the Sectorial Plan, ADER 7.3.1 project of the Horting Institute Bucharest on the 2019-2022 period, project supported from the funds of the Agriculture Ministery.

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