

The influence of some *Capsicum* rootstocks on bell pepper crops

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ABSTRACT

Bell pepper has an important content of vitamins (C, A, E and B), minerals and sugar. It ranks the fourth place in Romania, after tomatoes, onions and cabbage. Grafted bell pepper crops from Romania obtain higher productions compared to non-grafted bell pepper crops. The objective of the paper has been to establish the effect of some *Capsicum* rootstocks on some Romanian and Dutch bell pepper cultivars obtained in 2019 in the greenhouse from HORTING Institute. The biological material consists of cultivars of *Capsicum* genus: two scions (Dutch 'Menta' F1 bell pepper and Romanian 'Regal' bell pepper) and three rootstocks (Romanian 'L11A' and 'L12S' bell peppers and Dutch first-generation 'Foundation' hybrid). Dutch 'Menta' bell pepper and Romanian 'Regal' bell pepper are commonly cultivated in fields, greenhouses, and solariums. There were studies in 6 grafted plant variants and 2 non-grafted plant variants of 36000 plants/ha. Grafting has influenced the yield and quality of bell pepper fruits. Grafting has positively or negatively influenced fruit yield and the content of biochemical compounds in grafted crops. The results of this research require an extension of the intra and interspecific grafting of the bell pepper, respectively into different rootstocks for the Romanian bell pepper crops from greenhouses, solariums, and fields.

Keywords: Dutch bell pepper, grafting, quality, Romanian bell pepper, yield

INTRODUCTION

The bell pepper has an important content of vitamins (C, A, E and B) (Lagunovschi-Luchian and Vinătoru, 2016), mineral substances and sugar (Ciofu, 1996). It ranks fourth place in Romania, after tomatoes, onions and cabbage (www.madr.ro) and Dutch 'Menta' F1 bell pepper and Romanian 'Regal' bell pepper are commonly cultivated in field, greenhouses and solariums.

Some results regarding the influence of grafting on bell pepper exist in numerous researches. Leal-Fernández *et al.* (2013) found that the rootstock 'CM334' negatively affected all agronomic and morphological characteristics, the rootstock 'AR96029' had a positive effect on plant yield and the rootstock 'Tresor' induced an increasing number of fruits, without increasing the yield. Donas-Ucles *et al.* (2015) investigated some rootstocks ('Serrano de Morelos 2' or 'SCM-334', 'Japaleno', 'Oscos', 'AR 9604040' and 'Tresor') and concluded that there was no correlation between yield and plant vigor determined by the rootstock. López-Marín *et al.* (2017) studied the effects of some rootstocks ('Atlante', 'Creonte', and 'Terrano') and observed the increased yield. Therefore, there are conflicting results regarding the influence of rootstocks on bell pepper crops. The objective of paper

has been to establish the effect of some *Capsicum* rootstocks on the Romanian and Dutch bell pepper crops obtained in the year 2019 in greenhouse from the HORTING Institute.

MATERIALS AND METHODS

The study was done in the greenhouse of the HORTING Institute in 2019 year.

Biological material and experimental design

The biological material consists of cultivars of *Capsicum* genus: two scions (Dutch 'Menta' F1 bell pepper and Romanian 'Regal' bell pepper) and three rootstocks (Romanian 'L11A' and 'L12S' bell pepper and Dutch first-generation 'Foundation' hybrid). 'Menta' F1 and 'Foundation' F1 are from Rijk Zwaan Company, 'Regal', 'L11A', and 'L12S' are from SCDL Buzau. The external appearance of bell pepper fruits is shown in figure 1.



Figure 1. Pepper fruits

The experimental crops with bell pepper have been established at the density of 36000 plants/ha, in grafted and non-grafted variants grouped in randomized blocks.

The experience has been organized by eight variants, 30 plants/variant, 3 repetitions/variant), with two experimental factors:

- The first factor – scion
 - 1 – 'Menta';
 - 2 – 'Regal'.
- The second factor – rootstock:
 - 1 – 'Foundation';
 - 2 – 'L11A';
 - 3 – 'L12S'.

Eight variants with bell pepper have resulted, presented in table 1.

Table 1. Experimental variants with peppers

Variant	Scion	Rootstock	Planting density (thousands of plants/ha)
V1	'Menta' (control)	-	36
V2	'Menta'	'Foundation'	36
V3	'Menta'	'L11A'	36
V4	'Menta'	'L12S'	36
V5	'Regal' (control)	-	36
V6	'Regal'	'Foundation'	36
V7	'Regal'	'L11A'	36
V8	'Regal'	'L12S'	36

The experience represented a comparative crop established with the 8 bell pepper cultivars to the last decade of May (May 29, 2019) and maintained under classical technological conditions, in a glass greenhouse at the HORTING institute.

The general and specific works for the bell pepper crop were applied throughout the vegetation period.

Biometric determinations. The determinations regarding the total yield have been carried out by weighing the fruits in each research variant.

Biochemical analyses on pepper fruits. The biochemical analyses have been carried out on fruits harvested at consumption maturity, so: the soluble dry substance has been determined using the ABBE refractometer (Prisma model); the sugar amount has been determined by the Bertrand method; the vitamin C has been determined by using the spectrophotometric method (Sora *et al.*, 2019); total acidity has been determined by the volumetric method (Doltu *et al.*, 2021).

Statistical analysis. The statistical interpretation has been processed using analysis of variance (ANOVA) and Duncan's test, after Iordăchescu (1976).

RESULTS AND DISCUSSIONS

The fruits were harvested starting in the last decade of July (July 26, 2019).

The fruit production on grafted bell pepper plants has been influenced by grafting. It has been superior to the 'Menta' and 'Regal' bell pepper plants grafted into the Dutch 'Foundation' rootstock compared to the grafted plants into the Romanian 'L12S' and 'L11A' rootstocks and the non-grafted plants (table 2).

Table 2. The influence of rootstock on fruiting of bell pepper cultivars

Variant	No. of fruits /plant	Yield		Differences/plant	
		(kg/plant)	(t/ha)	kg	%
'Menta' (control)	8.7	1.38	49.68c	-	100
'Menta' x 'Foundation'	8.9	1.40	50.40d	0.02	101.4
'Menta' x 'L11A'	8.9	1.34	48.24b	- 0.04	97.1
'Menta' x 'L12S'	8.5	1.30	46.80a	- 0.08	94.2
'Regal' (control)	10.5	0.91	32.76c	-	100
'Regal' x 'Foundation'	12.1	1.12	40.32d	0.21	123.1
'Regal' x 'L11A'	11.3	0.80	28.80a	- 0.11	87.9
'Regal' x 'L12S'	10.3	0.82	29.52b	- 0.09	90.1

*values followed by the same letter do not differ significantly from the 5% significance level, Duncan test

Production increases have been obtained for the bell pepper cultivars grafted on the 'Foundation' rootstock compared to the control (non-grafted); these have been between 0.02 ('Menta') and 0.21 ('Regal') kg/plant (1.4 – 23.1%). Negative production differences have been recorded on the pepper variants grafted into the 'L11A' and 'L12S' compared to the non-grafted plants (control).

Colla *et al.* (2008) investigated some rootstocks ('Snooker', 'Tresor', 'RX360', 'DR08801' and '97.9001'.) for pepper (*Capsicum annuum* L.) grafting and an experiment was carried out to determine yield and fruit quality of two 'Edo' and 'Lux' bell pepper cultivars. Total and marketable yield and fruit number were significantly influenced by grafting. Grafted bell pepper plants produced 22-46% more yield than non-grafted plants (control) for the 'Edo' bell pepper. The grafted 'Lux' plants had 25% more yield in comparison to non-grafted plants. The use of grafted bell pepper plants represents a strategy for an increase in fruit yield (Ergun and Aktas, 2018).

The biochemical composition obtained in the bell pepper variants is shown in the table 3.

Table 3. Biochemical composition of bell pepper variants

Variant	Soluble dry substance (°R)	Acidity (g malic acid/100 g)	Total sugar (%)	Vitamin C (mg/100g)
'Menta' (control)	5.7	0.14	1.89	101
'Menta' x 'Foundation'	5.3	0.18	1.81	85.9
'Menta' x 'L11A'	4.8	0.18	2.62	67.3
'Menta' x 'L12S'	5.5	0.18	2.46	80.8
'Regal' (control)	6.5	0.18	2.71	82.6
'Regal' x 'Foundation'	8.1	0.21	2.79	156
'Regal' x 'L11A'	7.1	0.21	2.79	73.3
'Regal' x 'L12S'	7.0	0.21	3.13	91.1

The content of soluble dry substance from fruits has varied between the investigated variants; higher values have been obtained for all the grafted 'Regal' bell pepper variants (7 – 8.1°R) compared to the non-grafted variant (control) (6.5°R) and higher values have been obtained for the non-grafted 'Menta' bell pepper variant (control) (5.7°R) compared to the grafted 'Menta' bell pepper variants (4.8 – 5.5°R).

At titratable acidity, lower values have been obtained in the non-grafted variants (control) of 'Menta' bell pepper (0.14 g) and 'Regal' bell pepper (0.18 g) compared to the grafted variants of 'Menta' bell pepper (0.18 g) and 'Regal' bell pepper (0.21 g).

The nutritional qualities of fruits from the grafted bell peppers such as dry matter, total soluble solid contents, and titratable acidity were similar compared to those of non-grafted plants (Colla *et al.*, 2008).

The content of total sugar from fruits has varied between the investigated variants; slightly higher values have been obtained for the grafted variants of the 'Regal' bell pepper (2.79 – 3.13%) compared to the non-grafted variant (2.71%) and slightly higher values have been obtained for the 'Menta' bell pepper variants grafted into the 'L11A' and 'L12S' rootstocks (2.46 – 2.62%), then the non-grafted 'Menta' variant (control) (1.89%) and the 'Menta' variant grafted into the 'Foundation' rootstock (1.81%).

Soluble sugars (average contents: 7.2 and 7.6°Brix for the grafted 'Edo' and 'Lux' cultivars) in pepper fruits are not strongly affected by grafting (Colla *et al.*, 2008).

A higher value of vitamin C has been obtained in the non-grafted 'Menta' bell pepper variant (101 mg) compared to the values from the grafted variants (67.3 – 85.9 mg). An intermediate value of vitamin C has been obtained in the non-grafted 'Regal' bell pepper variant (82.6 mg) compared to the values from the grafted variants (73.3 – 156 mg).

Grafting favors the presence of bioactive compounds in the bell pepper (β -carotenes, vitamin C, lycopene, total phenols) and the antioxidant activity of bell pepper using some scion/rootstock combinations ('Jeanette'/'Terrano', 'Sweet'/'Robusto', 'Fascinato'/'Robusto', 'Orangela'/'Terrano' and 'Fascinato'/'Terrano'). 'Sweet'/'Robusto' had 1.3-fold higher content in vitamin C than 'Jeanette'/'Terrano', 1.2-fold more than 'Fascinato'/'Robusto', 1.16-fold more than 'Orangela'/'Terrano', and 1-fold more than 'Fascinato'/'Terrano'. 'Sweet'/'Robusto' registered an average content in vitamin C of 165.56 mg/100 g dry weight (Chávez-Mendoza *et al.*, 2015).

The correlation coefficients have been calculated for to highlight the correlation between the yield and sugar and vitamin C (figures 2 and 3).

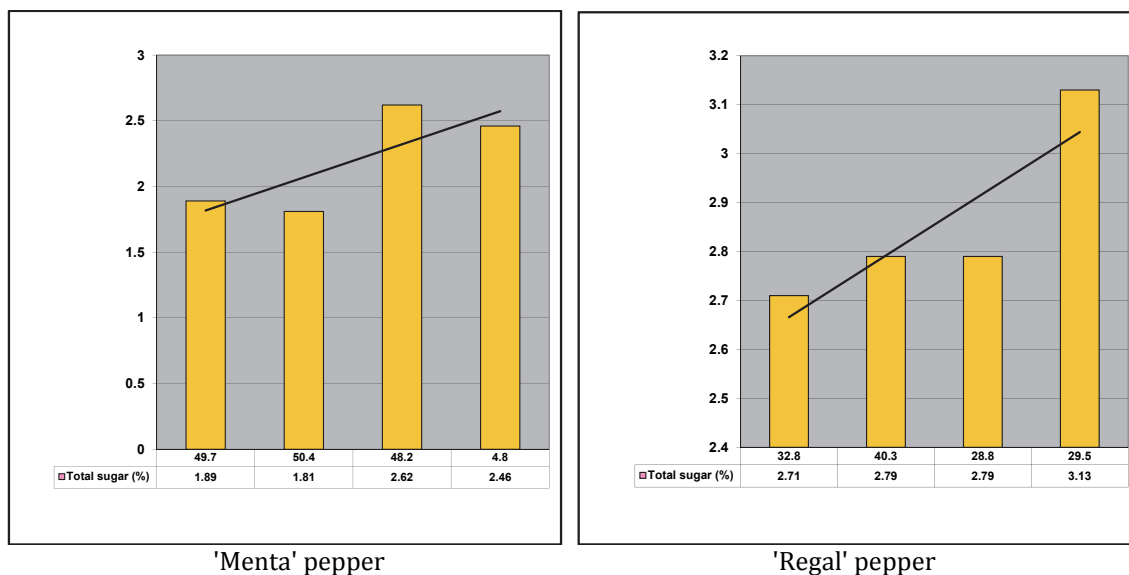


Figure 2. Correlation between yield and total sugar content

The coefficient of determination was positive between control plants and grafted plants, between yield and total sugar content ($r^2 = 0.6452$ 'Menta' and $r^2 = 0.7553$ 'Regal'); the significance of the correlation is distinctly significant.

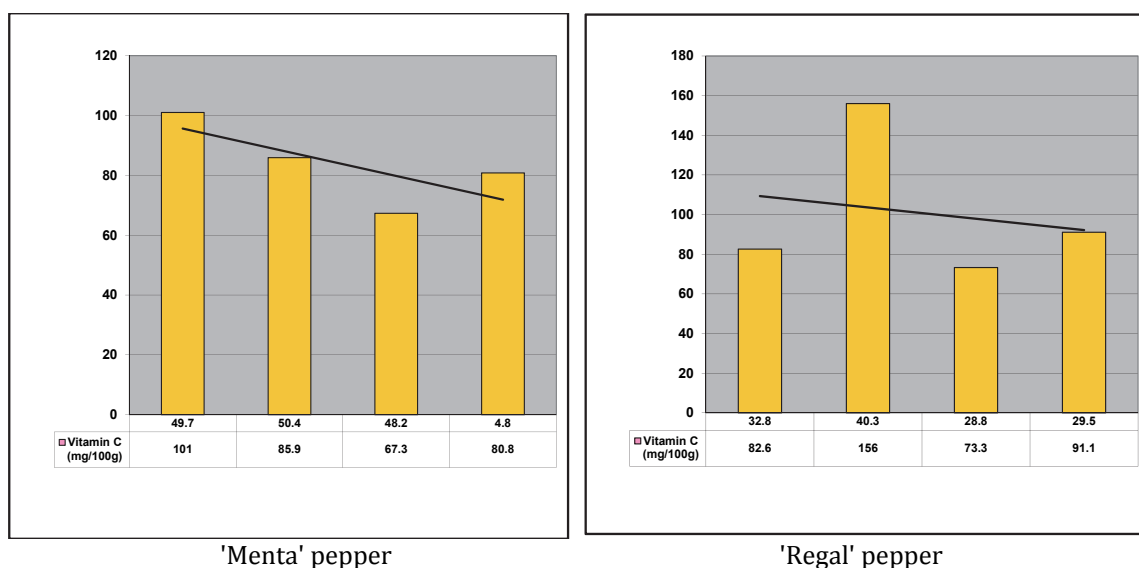


Figure 3. Correlation coefficients between yield and vitamin C

The coefficient of determination was negative between control plants and grafted plants, between yield and vitamin C ($r^2 = 0.5394$ 'Menta' and $r^2 = 0.0387$ 'Regal').

CONCLUSIONS

Grafting has influenced the yield and quality of bell pepper fruit.

The grafting has positively influenced the fruit yield ('Menta' and 'Regal' grafted into 'Foundation' rootstock) and the content of vitamin C ('Regal' grafted into 'Foundation' and 'L12S' rootstocks) either it has negatively influenced fruit yield ('Menta' and 'Regal' grafted

into 'L11A' and 'L12S' rootstocks) and the content of vitamin C ('Menta' grafted into 'Foundation', 'L11A' and 'L12S' rootstocks).

The rootstock has influenced the content of soluble dry substance, positively for the 'Regal' pepper and negatively for the 'Menta' bell pepper; positive to titratable acidity in all variants, positive to sugar in all variants, except for the 'Menta' bell pepper grafted into the 'Foundation' rootstock.

An optimal selection of rootstock before grafting is recommended to obtain an important fruit yield.

The results of this research require an extension of the intra and interspecific grafting of the bell pepper, respectively into different rootstocks for the Romanian bell pepper crops from greenhouses, solariums, and field.

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