

The Grafting Tomatoes Crop - an Alternative for Vegetable Growers

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Abstract. In Romania tomatoes represent the most important crops in greenhouses, generally adopting a continuous monoculture. Since crop rotation is rarely adopted, the reduction of yield, both in quantity and quality, progressively affects the crops. Investigations in Horting Institute showed that after 4 years of continuous tomato monoculture a yield reduction up to 48% occurred, thus making necessary the adoption of soil disinfestations practices or, other methods. The treatment of soil with methyl bromide was used only by large commercial farmers (107.72 tons methyl bromide in 2003). Since the adhesion to the Montreal Protocol, Romania government decided to phase out methyl bromide use starting 2005. Results of the demonstrative plots (MAKIS-project) obtained in 2008 - 2010 indicated for the Romanian conditions, the following methyl bromide alternatives were suitable for soil disinfestations: metham sodium (chemicals methods), and grafting tomatoes (non-chemical method). Grafting tomatoes cultivars with high quality and productivity on rootstocks that are resistant to the soil pests and diseases is a method known for years ago, but which was improved and quickly spread in the last years. The main result of the grafting process is the increase of the resistance against soil diseases and pests, respectively the quality of fruits.

Keywords: marketable production, quality, nutritional value, pathogens, nematodes

INTRODUCTION

Soilborne pathogens are very destructive in vegetables crops and one of the most limiting factors to farmer's income. Their management worldwide has been based on pre-plant soil fumigation with methyl bromide, a compound whose phase-out procedure was initiated in the Montreal Protocol (1992) due to its hazardous effects on the environment (Bogoescu *et al.*, 2007; Gullino *et al.*, 2003). Since 1972 the consumption of methyl bromide has started in Romania in greenhouses. About 107.72 tons of methyl bromide has been used in 2003 for agricultural uses in Romania (79 tons in greenhouses vegetables crops and 28.72 tons for grain fumigations) (Bogoescu *et al.*, 2005).

The use of methyl bromide in soil treatments for plant protection (fumigation applications) in Romania is banned from 2005 January 1st (Gov Ordinance no. 89/1999, approved by Law No. 159/2000, art. 9). In Romania the tomatoes represent the most important crops grown under protection, generally adopting a continuous monoculture. Since crop rotation is rarely adopted, the reduction of yield, both in quantity and quality, progressively affects the crops, thus making necessary the adoption of soil disinfestations practices or others alternatives. Echevarría *et al.*, (2003) show that grafting is one of the most promising techniques used for the substitution of methyl bromide. The research has, therefore, been focused on finding effective non-chemical alternatives to this fumigant in order to control soil borne pathogens and nematodes, the grafting tomatoes crop.

This paper is referring to the results obtained during 2008 – 2010, in the frame of MAKIS Project "Grafted plants crops technology–biological alternative to Methyl bromide in

protected crops”.

MATERIALS AND METHODS

The demonstrative plots were organized in 2010 on tomatoes cultivated in demonstration trials for testing this alternative to methyl bromide, to control the pathogenic fungi on roots and root knot induced by nematodes, at the Horting Institute (Bucharest, Romania). The works were conducted in the institute pilot greenhouse, covered with glass and unheated on the demonstrative plot of 0.8 ha. It used the following combinations (rootstock x scion): Titron x Alambra F1, Titron x Cypriana F1. Beaufort x AlambraF1, Beaufort x Cypriana F1, Konkurabe x Alambra F1, Konkurabe x Cypriana F1, Suketto x Alambra F1, Suketto x Cypriana F1, Experimental variants were organized:

V1: normal plants -24 000 plants/ha

V21: grafted plants - 15 000 plants/ha(one stem)

V22: grafted plants - 15 000 plants/ha,(two stems)

V31: grafted plants - 12 000 plants/ha,(one stem)

V32: grafted plants -12 000 plants/ha,two stems)

Experimental variants were organized in randomized blocks of three repetitions,as follows:

V1 : 1000 m² with 2400 plants

V21: 1000 m² with 1500 plants

V22: 1000 m² with 1500 plants

V31: 1000 m² with 1200 plants

V32: 1000 m² with 1200 plants

In the comparative analysis, the recorded results are presented as mean / variant on combinations of rootstock x scion,for grafted plants, analyzed compared with the average results of the normal plants.

The efficiency of grafting tomatoes method was assessed by measuring:

1. marketable production
2. appearance of the first harvest
3. fruits' quality
4. nutritional value of fruits

5. severity of attack induced by *Fusarium oxysporum f.sp. lycopersici*, severity of root galls induced by nematodes [root index (0-5), after Lamberti, 1971 and Di Vito, 1979]. The incidence of *Fusarium* and the presence of galls induced by nematodes of the genus *Meloidogyne* were visually assessed at the end of the trials on 15% of the plants harvested from the middle of the plots. The following index descriptors were used:

- 0 = no galls;
- 1 = slight infection, not widespread galls, presence of 1-5 galls located only on few roots;
- 2 = slight infection, widespread galls, presence of no more than 20 galls well spread on root system;
- 3 = infection with widespread galls, more than 20 galls evident and well spread on root system;
- 4 = strong infection, root system cut down and deformed due to the presence of big galls on the main roots;
- 5 = very strong infection, root system cut down and totally deformed due to the presence of big galls, absence capillary roots.

The root index (0-5) was calculated as follows:

$\frac{\sum \text{nematode index of all plants}}{\text{Number of plants}}$

Number of plants

For pathogens determined there were calculated the frequency, intensity and level of pest attack in the experimental variants.

$$F\% = \frac{N \times 100}{N_t}, \text{ where:}$$

N – no. attacked plants

N_t – total plants analyzed

$$I(\%) = \frac{\sum (i \times f)}{n}, \text{ where:}$$

i = % index

f = number of plants attacked

n = total number of plants

$$GA\% = \frac{F\% \times I\%}{100}$$

Statistical analysis was performed by Duncan's test.

RESULTS AND DISCUSSION

Marketable production

In order to reveal the influence of different crop methods (normal plants and grafted plants), marketable production data were collected (Fig.1).

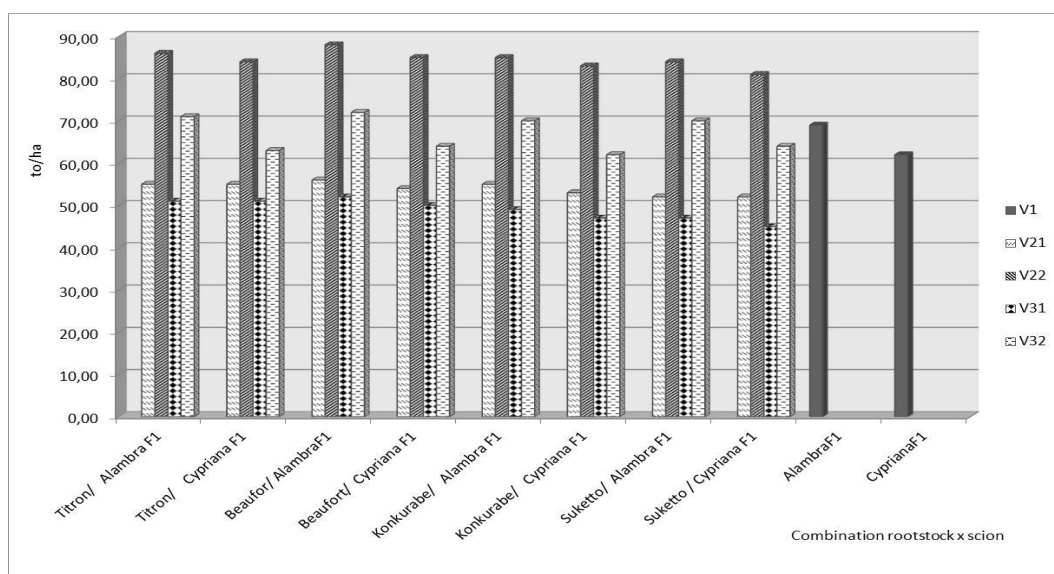


Fig. 1. Influence of crop system on the marketable production (tones/ha)

The analysis of the data presented in figure 1, showed a higher production at combinations of rootstock / scion : Beaufort/AlambraF1 (67.00 tons), Titron / Alambra F1 (65.75 tons) and Konkurabe / Alambra F1 (64.75 tons); regarding the influence of the leading system stem on the obtained production, were evidenced by a higher yield the variants that grafted plants have been lead with two stems: V22 (84,5 tone/ha) respectively V32 (67,0 tone/ha), comparativ with the control – the normal plants - where the average production was of 65.5 tons / ha.

Appearance of the first harvest

In order to establish the influence of culture system on the occurrence of the first

harvest, as an expression of early production degree, observations and determinations were done regarding the first harvest date and the number of days from planting to first harvest.

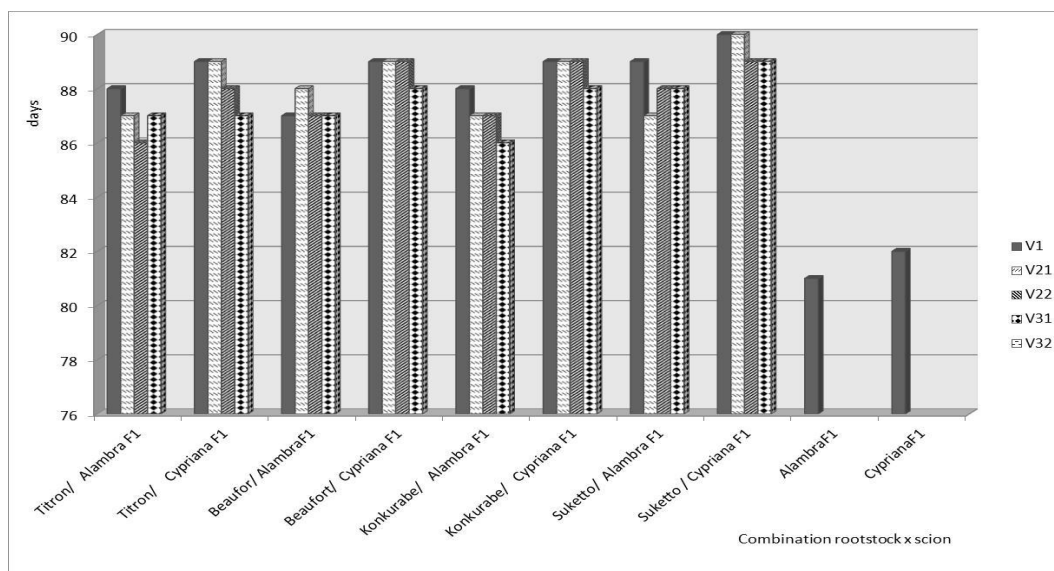


Fig. 2. Number of days from planting to first harvest

Data recorded and presented in figure 2 show a delay of the first harvesting to the tomatoes grafted with an average of 6 – 7 days, as compared with the first harvesting of the non-grafted tomatoes. The differences of time between variants with different densities or different combinations were not significant.

Fruits quality

In figure 3 there are presented data which refers to the influence of culture system on the percentage of Class Extra and First tomatoes fruits. The fruit quality was assessed according to the quality standards for fresh fruits and vegetables SR 1421/2003, tomatoes.

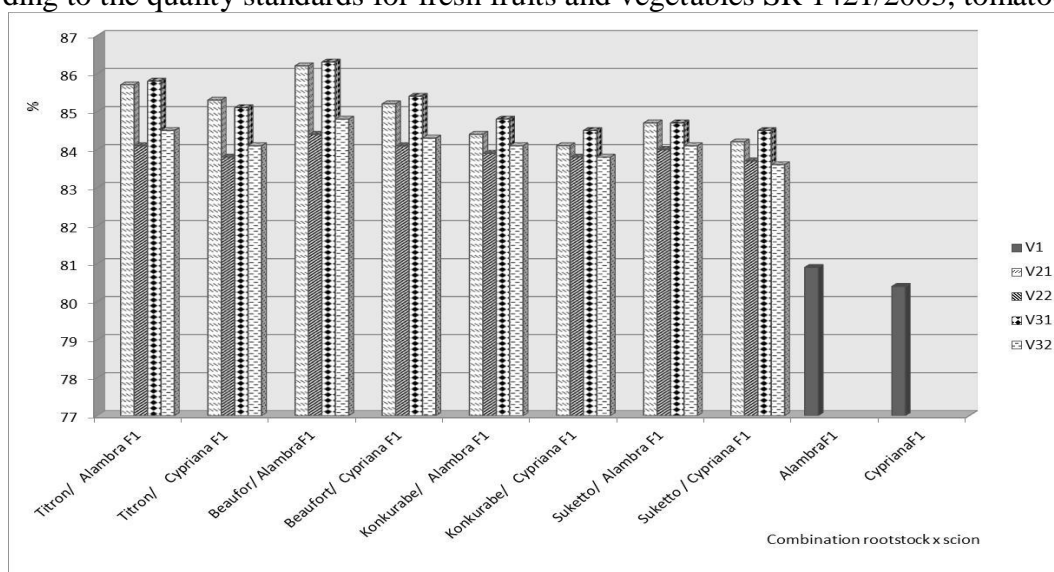


Fig.3. Influence of the crop system on the percentage of Class I tomatoes (%)

The analysis of the data presented, showed an improvement of commercial quality at grafted plants (84,6% tomatoes of Class Extra and First); tomatoes from non-grafting plants has an average percentage of Class Extra or First tomatoes of only 80,7%. The differences between cultivation or combinations between rootstock / scion were not significant.

Nutritional value of fruits

There were made determinations on dry matter content and total C vitamin from tomatoes fruits. Determinations were made on standard samples (3 kg fruits / sample). Samples were taken from mass product in two harvests. Analyses were performed under laboratory methodology. The results presented represent (Fig.4) the average of the both harvest.

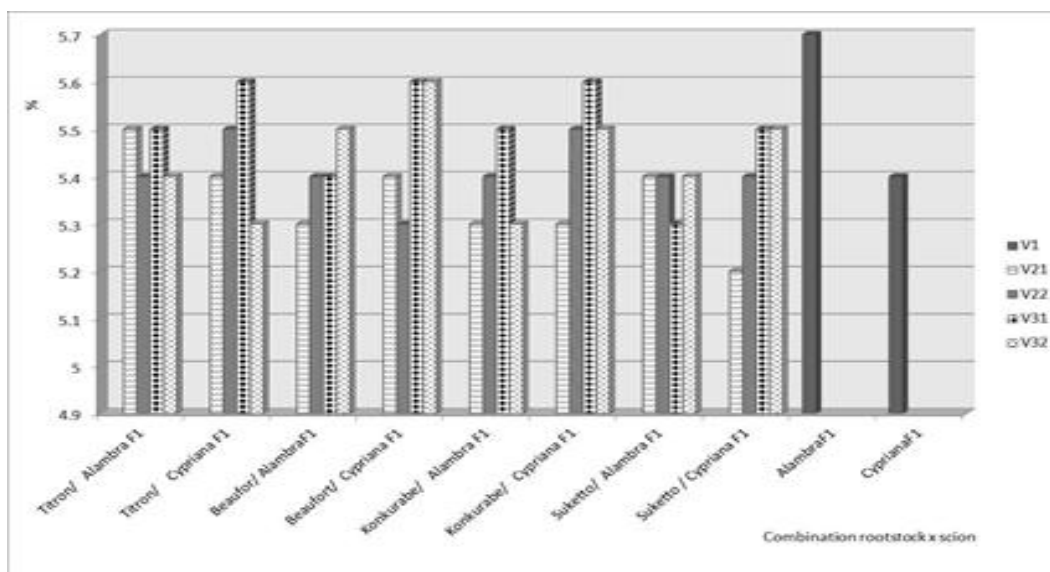


Fig. 4a. Influence of crop system on the soluble content dry matter

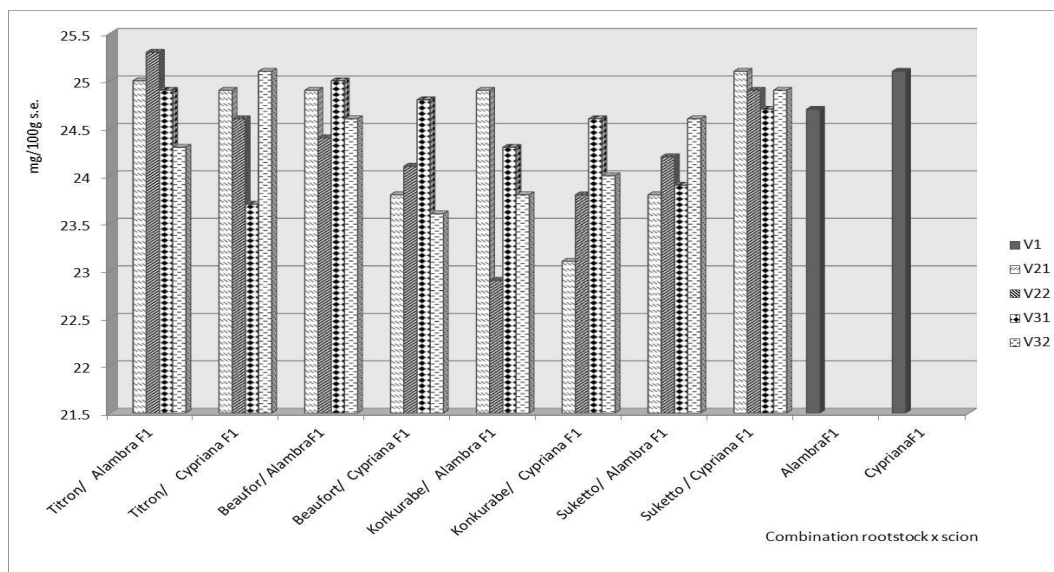


Fig. 4b. Influence of crop system on the content of C vitamin

The dry matter content is expressed in percentages and the C vitamin in mg/100g-e. Recorded results which refer to some indicators of quality nutrients (dry matter and C vitamin

content) determine on tomatoes fruits have shown a slight decrease of content in fruit that came from the grafted plants. So, in grafted tomatoes, dry matter content was reduced on average by 0,2% and C vitamin content was the lowest with 0.5mg/100g ; practically the nutritional value of tomatoes fruits expressed by dry matter content and C vitamin is the same for both culture systems(grafted plants or normal plants).

The grafting influence on the degree of tolerance and resistance of tomatoes to the soil-borne pathogens and nematodes.

Following observations on the culture substrate, there were identified species of *Fusarium oxysporum f.sp. lycopersici* .The grafted plants showed resistance to attack of *Fusarium oxysporum* and *Meloidogyne incognita*(0,06%) comparing with non-grafted tomatoes plants where the level of *Fusarium oxysporum* attack was of (0,99-1,87%) and of (0,07-1,00 %) for *Meloidogyne incognita*, (Fig.5).

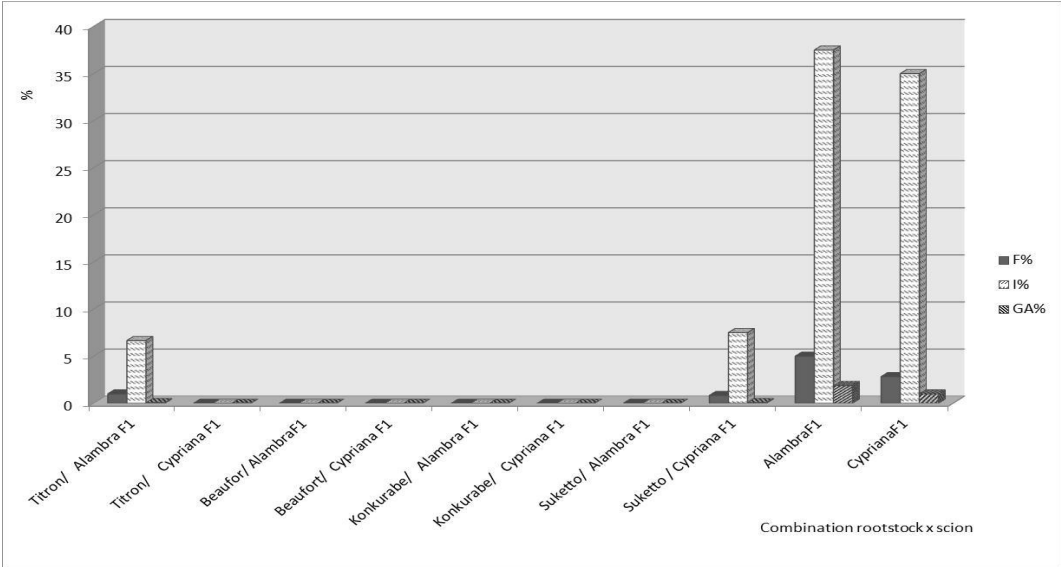


Fig 5a. The grafting influence on the degree of tolerance and resistance of tomatoes to the *Fusarium oxysporum f.sp. lycopersici*

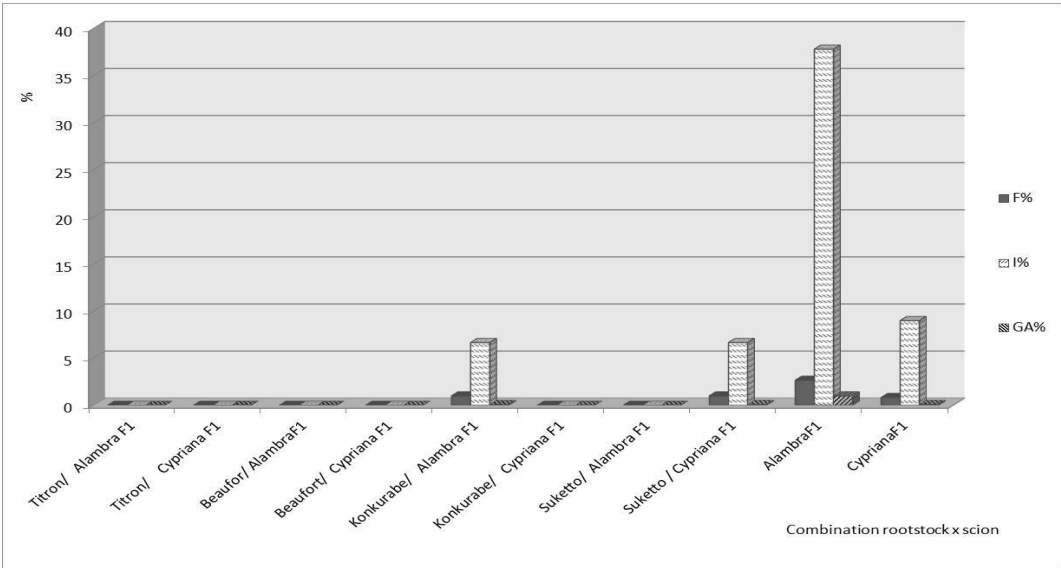


Fig 5b. The grafting influence on the degree of tolerance and resistance of tomatoes to the *Meloidogyne incognita*

Analysis of presented data reveals the character of rootstocks resistant to the attack of the *Fusarium oxysporum* and *Meloidogine incognita* compared to results recorded in non-grafted cultivars which showed a susceptibility to attack of soil pathogens and nematodes.

CONCLUSIONS

The obtained results have permitted to draw some conclusions referring to the influence of the use of grafted tomatoes:

- the marketable products obtained under conditions of growing grafted tomatoes increased by more than 5,1%;
- the use of grafted tomatoes led to a delay of the first harvesting period with 6-7 days compared with the crop production non - grafted;
- the marketable product quality has improved through the use of grafted plants; the percentage of tomatoes from Class Extra and First was up to 5% higher at grafted tomatoes crop;
- nutritional value of tomatoes, expressed by dry matter content and C vitamin, not significantly changed by grafting cultivars on rootstock;
- grafting process led to significant reduction in the incidence of attack produced by *Fusarium oxysporum f.sp. lycopersici* and *Meloidogine incognita*;
- reduce number of seedlings necessary for planting one ha of grafted tomatoes with over 38%.

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