Grafting Watermelons Crop – Non Chemical Methyl Bromide Alternative in Romanian Horticulture

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Abstract. In Romania, the watermelons represent one of the most popular crops. The watermelons crop is particularly sensitive to the attack by soil diseases and nematodes. 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, 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 2009 indicated for the Romanian conditions, the following methyl bromide alternatives were suitable for soil disinfestation: metham sodium (chemicals methods), and grafting watermelons (non-chemical method). Grafting watermelons 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.

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

INTRODUCTION

One of the most limiting factors to farmer income (in vegetables crops) are soil borne pathogens and nematodes attacks. 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 (Gullino et al., 2003; Bogoescu et al., 2007). Methyl bromide is, probably, the only fumigant that is effective against nematodes, weeds, pathogens, and insects. About 107.72 tons of methyl bromide has been used in 2003 for agricultural purposes in Romania (79 tons in greenhouses vegetables crops and 28.72 tons for grain fumigations) (Bogoescu et al., 2005). According to Montreal Protocol (1997), methyl bromide, as an ozone-depleting compound, has been scheduled to be phased out of production, importation and use as an agricultural chemical. The use of methyl bromide in soil treatments for plant protection (fumigation applications) in Romania has been banned starting January 2005 (Gov Ordinance no. 89/1999, approved by Law No. 159/2000).

In Romania, the watermelons represent one of the most popular crops. The watermelons crop is particularly sensitive to the attack of soil diseases and nematodes. 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 and collaborators (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 watermelons crop.

MATERIALS AND METHODS

The demonstrative plots were organized in 2009 on watermelons 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). The watermelon hybrid Cicerio F1 (Ergon Seed) was grafted on the resistant rootstock ES30900 (Ergon Seed). The plots, with an average surface of 500 m², were organized in a completely randomized block design with three replicates. Experimental variants were organized:

V1: standard plants - 7500 plants / ha
V2: grafted plants - 5500 plants / ha
V3: grafted plants - 4000 plants / ha

The efficiency of grafting watermelon 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. *cucumerinum*, severity of root galls induced by nematodes [root index (0-5), after Lamberti, 1971 and Di Vito, 1979] and the total marketable yield. 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:

$$\Sigma \text{nematode index of all plants}$$

Number of plants

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

$$F\% = \frac{N_f}{N_t} \times 100$$

where:

- $N$ – no. attacked plants
- $N_t$ – total plants analyzed

$$I(\%) = \frac{\Sigma i f}{n}$$

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 (standard plants and grafted plants), marketable production data were collected (Fig. 1). The use of 4000 grafted plants/ha brought a significant higher yield, of 88t/ha. The results showed a significant difference between standard plants crop and grafted plants crop (over 34t/ha). At the same time, it showed a significant difference between grafted variants with 5500 plants/ha and 4000 plants/ha, respectively.

![Fig. 1. Influence of crop system on the marketable production](image)

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.

Data recorded and presented in Figure 2 show a delay of the first harvesting to the watermelons grafted with an average of 6 days, as compared with the first harvesting of the non-grafted watermelons.

![Fig. 2. Number of days from planting to first harvest](image)
The differences of time between variants with different densities (V2 and V3) were not significant. Recorded results confirmed very early feature of the hybrid CicerioF1.

Fruits’ quality

In Figure 3 there are presented data which refers to the influence of culture system on the percentage of Class I fruits crop watermelons. Fruit quality was assessed according to the quality standards for fresh fruits and vegetables SR 3654: 2003, watermelons.

The analysis of the data presented showed an improvement of commercial quality at grafted plants (88.9% and respective 93%, Class I watermelons); watermelons from non-grafting plants has an average percentage of Class I watermelons of only 69.90%.

Fig. 3. Influence of the crop system on the percentage of Class I watermelons

Nutritional value of fruits:

There were made determinations on dry matter content and total carbohydrate from watermelons. Determinations were made on standard samples (6 melons/sample). Samples were taken from mass product in two harvests. Analyses were performed under laboratory methodology, respectively; refractometry method (STAS 5956/71) to determine dry matter and soluble Bertrand method for determining the total carbohydrate. The results presented represent the average of the both harvest (Fig.4).

Fig. 4. Influence of crop system on the content soluble dry matter and total carbohydrate

The dry matter content and total carbohydrate is expressed in percentages. Recorded results which refer to some indicators of quality nutrients (dry matter and total carbohydrate
content) determine on watermelons have shown a slight decrease of content in fruit that came from the grafted plants. So, in grafted watermelons, dry matter content was reduced on average by 1.5% and total carbohydrate content was the lowest with 0.66%; practically the nutritional value of watermelons expressed by dry matter content and total carbohydrates is the same for both culture systems.

The grafting influence on the degree of tolerance and resistance of watermelons to the soil-borne pathogens and nematodes. Following observations on the culture substrate, there were identified species of *Fusarium oxysporum*.

The grafted plants showed resistance to attack of *Fusarium oxysporum* and *Meloidogyne incognita* comparing with non-grafted watermelons plants where the level of *Fusarium oxysporum* attack was of 0.56% and of 0.80% for *Meloidogyne incognita* (Tab. 1).

The grafting influence on the degree of tolerance and resistance of watermelons to the soil-borne pathogens and pests

<table>
<thead>
<tr>
<th>Culture technology</th>
<th><em>Fusarium oxysporum</em></th>
<th><em>Meloidogyne incognita</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F%</td>
<td>1%</td>
</tr>
<tr>
<td>Grafting plants</td>
<td>0.027a</td>
<td>0.450m</td>
</tr>
<tr>
<td>No grafting plants</td>
<td>3.995b</td>
<td>16.950n</td>
</tr>
</tbody>
</table>

* Within a column, in a group of letters (a…b) for frequently, (m…n) for intensity and (o…p) for degree touch , the values noted with the same letter do not present significant difference after the Duncan test for p = 5%

Analysis of presented data reveals the character of rootstocks resistant to the attack of the *Fusarium oxysporum* and *Meloidogyne incognita* compared to results recorded in non-grafted cultivars which showed a susceptibility to attack of soil pathogens and nematodes. Data analysis confirms the tolerance effect of grafted plants to *Meloidogyne* spp (Oda, 1993).

**CONCLUSIONS**

The results obtained in 2009 have permitted to draw some conclusions referring to the influence of use watermelon grafted cultivated in Romanian:

- marketable production obtained under conditions cultivars grafted plants increased by more than 34 tons/ha;
- the usage of watermelons grafted plants in culture led to a delay of the first harvesting period with cca.6 days compared with the crop production non-grafted;
- marketable product quality has improved through the use of grafted plants: the percentage of watermelons in Class I was up to 24% higher in grafted watermelon crop;
- nutritional value of watermelon, expressed by dry matter content and soluble carbohydrates, not significantly changed by grafting cultivars on rootstock;
- grafting process led to significant reduction in the incidence of attack produced by *Fusarium oxysporum* var. radices and *Meloidogyne incognita*;
- reduce number of plants necessary foundation watermelons culture with over 42%.

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REFERENCES


