RESULTS ON ESTABLISHING THE TECHNOLOGY FOR OBTAINING THE TOMATOES GRAFTED SEEDLINGS DESIGNED FOR GREENHOUSES

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Abstract: The researches aimed to establish the technology for obtaining the tomatoes grafted seedlings for greenhouses in the particular conditions from Romania.

INTRODUCTION

Grafting 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 method is based on the merge between a crop variety (scion) and a wild variety, the last one possessing a robust root system, a high resistance to the soil pests and diseases and tolerance to some less favorable conditions of some soil types and environment (Edelstein, 2004). The main result of the grafting process is the increase of the resistance against soil diseases such as Fusarium ssp. in the case of Cucurbitaceae, Fusarium, Verticillium in the case of Solanaceae and nematodes (Bogoescu, 2007). It is extremely important during the grafting process to ensure the vascular fusion between the scion and rootstock by using a cut that maximizes the contact surface and creating the proper conditions for close contact between those two plants (Assenza, 2004).

In our country, between 1970 and 1973, there were some initiatives regarding grafting tomatoes seedlings in order to use them in greenhouses, but they were not put in practice at full potential.

The results described in this paper are about the researches carried out between 2005 and 2008 at the Research and Development Institute for Processing and Marketing of the Horticultural Products “Horting”. These researches aimed to establish the technology for obtaining the tomatoes grafted seedlings for greenhouses in the particular conditions from Romania.

MATERIALS AND METHODS

The work was carried out in the experimental greenhouse of the institute. This greenhouse is specialized in producing vegetables seedlings, it has a 1450 square meters surface, it is protected against condense by a double layers cover with an under pressure air layer as thermal insulator and it is equipped with a system for shadowing, ventilation and cooling of the grafting room (Fig. 1, 2).
In order to establish the compatibility between scions and rootstocks, the following crop varieties were used:
rootstock x scion (hybrid F1):
Titron x Alambra; Beaufort x Alambra; Konkurabe x Alambra; Suketto x Alambra;
Titron x Cypriana; Beaufort x Cypriana; Konkurabe x Cypriana; Suketto x Cypriana;
The main characteristics of the used rootstocks are:

**Titron** – is resistant to: Tomato mosaic tobamovirus pathotype: 0, 1, 2; Verticilium albo-atrum; Fusarium oxysporum var. lycopersici race, 0, 1; Fusarium oxysporum radicis-lycopersici race,0,1; Meloidogine ingognita; Cladosporium fulfum a,b,c,d,e; Pyrenochaeta lycopersici; Verticillium dahliae.

This rootstock is recommended for use particularly on soil which are infested with nematodes; it is tolerant to the Pyrenochneta lycopersici attacks; it offers rusticity and robustness to the scion.

**Beaufort** – is resistant to the: Tomato mosaic tobamovirus pathotype 0,1,2; Clavibacter michiganensis subsp. Michiganensis; Verticilium albo-atrum; Fusarium oxysporum radicis-lycopersici race 2; Cladosporium fulfum; Pyrenochneta lycopers; Meloidogyne incognita; Meloidogyne javanica.

Beaufort has been for a long time the standard root stock for tomatoes crops.

It has a high robustness and good tolerance for grafting for many cultivars and offers them an increased robustness when they are cultivated on soil, as well as on mineral wadding. The resistance against Pyrenochneta lycopersici attack is higher than the resistance of the cultivated hybrids that possessed that characteristic. It develops a root system very strong. The Beaufort rootstock is recommended for soils which are infested in a very high degree with Pyrenochneta. As a result of grafting, very robust plants are obtained.

**Konkurabe** – is resistant to the: Tomato mosaic tobamovirus pathotype 0,2; Ralstonia solanacearum; Verticilium albo-atrum; Verticillum dahliae; Fusarium oxysporum radicis-lycopersici race 0,1; Pyrenochneta lycopersici; Meloidogine ingognita.

This rootstock has a middle level of robustness (where on the scale of robustness 1 is very low and 5 is very high, it has a level of 2.5).

The rootstock has superficial roots. This is why it is recommended for soils with a high humidity level.

**Suketto** – is resistant to the: Tomato mosaic tobamovirus pathotype 0,2; Ralstonia solanacearum; Verticilium albo-atrum; Verticillum dahliae; Fusarium oxysporum radicis-lycopersici race 0,1; Pyrenochneta lycopersici; Meloidogine ingognita.

This rootstock has a high level of robustness (where on the scale of robustness 1 is very low and 5 is very high, it has a level of 4).
The hypocotyls of this rootstock is thin. The rootstocks with thin hypocotyls have better results when grafted. Because of its special robustness, this rootstock is used for crops with longer harvest cycle. The main characteristics of the used scions are the following:

**Alambra F1** – F1 Hybrid with a nonspecified port, type “Long Shelf Life”, fit for cultivation in protected areas and on the field. The plants robust and has a rich foliage, with internodes of medium length. It fructifies in racemes of 5-6 fruits. The fruits reach the maturity early. The fruits are globular, with a medium weight of 160-170 grams. When mature, the fruits are bright red. It has resistance to: Tobacco mosaic tobamovirus pathotype 0, Cladosporium fulvum race 5, Fusarium oxysporum f.sp. lycopersici race 2, Verticillium albo-atrum, Meloidogyne sp.

**Cypriana F1** - F1 Hybrid with a nonspecified port, fit for cultivation in protected areas and on the field. The hybrid is robust enough and has foliage that covers it well. The fruits are round -a little flattened, with a uniform bright red colour; the medium weight of fruits is 140-160 grams, with a nice solidity. It has a high resistance to the following: Tobacco mosaic tobamovirus pathotype 0, Fusarium oxysporum f. sp lycopersici race 1, 2, Verticillum albo-atrum, Meloidogyne sp. and a middle level of resistance to Tomato yellow leaf curl begomovirus.

The results are relating to:

a) Establishing the compatibility between the rootstocks and scions that are cultivated in Romania;
b) Identifying the environmental requirements of the plants during the grafting process;
c) Establishing the technologies for obtaining grafted seedlings of tomatoes and cucumbers.

**RESULTS**

Regarding the combinations obtained in the greenhouse, there were no rejections or physiological deteriorations caused by a potential incompatibility between rootstock and scion. The medium percentage for joining was 98.3% and the productivity of workers for the grafting activity was 105 grafted plants/hour/person.

Consequently to the carried out researches, the technology for obtaining grafted seedlings of tomatoes was established. It implies the following steps:

1. Seeding the rootstock;
2. Seeding the scion;
3. Preparing for grafting;
4. Grafting;
5. Forming the callus;
6. Transferring the seedlings from the tunnel for callus forming in the growing space.

1. Seeding the rootstock

It is carried out using the standard method. The date for seeding the rootstock, as compared with the date for seeding the scion, is established based on a germination test. The test takes into account the fact that the optimum time for grafting is when the diameters of the rootstock’s stem and scion’s stem are equal. The optimum diameter for both the rootstock and scion is 1.5mm.
It is possible for the variety to grow faster than the rootstock. The grow speed of the scion can be adjust by controlling the temperature parameter. The grafting can be carried out after 17-18 days following the plants springing. Starting with the 11th day after plants springing, they will be kept at a temperature lower than 19C, in order to ensure a higher robustness to the scion.

2. Seeding the scion
The date for seeding depends on the used rootstock and on the characteristics of the scion, as well as on the greenhouse’s microclimate. It is absolutely necessary to conduct a germination test. This test will establish:
- capacity to germinate and germination energy;
- number of days from seeding required by rootstock in order to became proper for grafting process.

The seeding is done in cell trays with 240 cells/tray, on a peat support. In generally, the tomatoes’ rootstocks germinate easily, so germination using dark is not recommended.

After seeding, the trays will be covered with transparent polyethylene layer, or they will be placed in places with high relative atmospheric humidity in order to avoid dehydration of the seeds.

It is necessary to protect the trays against direct sun radiations, too.

Required germination conditions:
- Temperature: 24-25C
- Relative atmospheric humidity: 80%
- EC: 1.5 – 1.8 mS
- pH: 6.0 – 6.5
- Light intensity: 4500lux/mp, between 05.00 – 18.00 hours.

The polyethylene layer will be removed as soon as the first plants springing. If the stems are too short, the trays can be placed under a black polyethylene layer for no longer than 12 hours in order to elongate the stems. Sorting and spacing out the plants are required in order to obtain uniform rootstocks with a proper height. The plants are spaced out in trays with 120 or 80 cells, after 5-6 days following the plants’ springing.

The sorting of the rootstocks’ plants is carried out when the differences between plants are substantial, but no latter than two days before grafting. Until grafting, the rootstocks seedlings are kept at 18-20 C for 18 days.

3. Preparing for grafting
The grafting is carried out using indirect light and requires an adequate shadowing if the weather is too sunny.

Tubes for grafting of different diameters, consistent with those of the rootstocks and scions, and razors are to be provided. The tubes can be made of plastic or silicon.
The recommended work temperature is 21-22°C.
Smoke is not allowed during grafting.
Disinfection of the hands using Virkon or other disinfectant is mandatory. Preferably, the grafting will be done under a tunnel of transparent plastic layer in which the relative humidity will be 80%. The plants will not be watered with 2-3 before grafting, in order to avoid too high osmotic pressure in the roots.

4. Grafting
The first step consists in cutting off all the tops of the rootstocks from a tray in an angle of 45 degrees. The oblique cut will increase the contact surface between rootstock and scion. The scraps will be removed immediately in order to prevent them to mix with the scions. It is recommended to keep the cotyledonated leaves of the rootstock, but the point of grafting will be no higher than 2-2.5 cm from the culture support (if the point of grafting is too low, there is a possibility for the scion to develop adventitious roots; if it is too high the extremity of the grafting tube will weight too much and there is a risk to bent and break) (Figure 5, 6).

Figure 5
Rootstock, scion, tube for grafting

Figure 6
Cutting the rootstock in a 45 degree angle

The silicon tubes are attached to the cut plants. It is recommended the tube to be not too large, on the contrary, a little tight.

The plants for scions will be sorted by dimensions, after that they will be cut. The scion will be cut under the same angle as the rootstock. There will not be cut a large number of plants, at the most the number required for a tray.

The optimum diameter is 1.5mm. The thickness of the scion where it will be cut must be the same with the thickness of rootstock’s section.

When the temperature is higher it is recommended to moisten the scion before in order to avoid dehydration.

The scion will be cut in a manner that will ensure that at least two real leaves exist. However, too many leaves on the scion can weight too much and the plant can break.

The scion that is oblique cut under a 45 degree angle will be attached to the tube, ensuring a perfect contact with the rootstock (Figure 7).

Figure 7
Attaching the rootstock and scion to the grafting tube

Figure 8
Tunnel in the 8th day from grafting
The tubes have cylinders for sustaining the stem. That will prevent the falling down, the bending and the breaking of the grafted plants. The trays containing grafted plants will be introduced in the tunnel for callus forming, as soon as the plants are grafted, in order to avoid the fainting of the plants. The tunnel will have the relative atmospheric humidity and the required temperature for carrying out in optimum conditions the callus forming process.

The optimum temperature that is recommended inside the tunnel is 23-25°C with a maximum temperature no higher than 28 – 29°C, when relative air humidity is 98 -100%. A higher temperature will decrease the rate of taking roots. Every tray for which the grafting process is finalized will be put into the tunnel. The tunnel will be hermetically closed after each loading.

In order to ensure the success of the callus forming process, it will not be allowed the direct sunlight to reach the grafted seedlings, in this way avoiding the fainting of the plants.

5. Forming the callus
The seedlings will be kept in the closed tunnel for 3 days.
In the 4th day, the rootstock and scion will start to merge.

The state of vegetation will be kept under observation. The grafted seedlings must be turgescent and not fainted. If the plants look fainted, it is required to water them with very fine water particles. In the 5th day, it will be ensured a slow ventilation and the plant will be watered. A small control window will be provided by leaving a small airing aperture in the polyethylene layer tunnel. It is very important to increase the intensity of ventilation gradually. A sign that the grafting succeed is the erect position of the grafted plants from the tunnel. In the 6th day, the airing aperture is enlarged and from the 7th day the polyethylene layer can be removed definitively (preferably in the morning or evening) (Fig.8).

7. Transferring the seedlings from the tunnel for callus forming in the growing space.
After the 7th day, the plants are transferred and they are handled respecting the classic technology for obtaining seedlings. The only particular operation consists in removing the plastic grafting tube when the rootstock and scion have completely merged. If the tube is made of silicon, there is no need to remove it, because it will fall when the plant’s diameter will grow. The possible transplantation of the grafted plants in the cubs can be realized after 9-10 days following the grafting.

CONCLUSIONS

It is possible to obtain tomatoes grafted seedlings for greenhouses, in the particular Romanian conditions.
In order to achieve this aim it is required to create specific microclimate conditions. This is possible in greenhouses that are adequate for these activities.
The rate of taking roots when grafting process is applied is over 98%.

REFERENCES