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DOCTORAL DISSERTATION

„Research concerning engrafted trees technologies improvement

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SUMMARY

Rootstocks utilization in deciduous fruit tree planting material production is practice both for propagation of valorous varieties and for amelioration of fruit tree agroproductive characteristics.

Scion growth and development is influenced by many factors (scion's vigour, potential vigour of the rootstock-scion association, climatic factors, soil, agrotechnical and phytopathological factors), but one of the most important is choosing of rootstock and/or interstock. The most of these factors interact and determine vigour and growing rhythm of scion shoots with direct implications upon adult fruit tree's dimensions.

The mechanism by which rootstock brings about their effects on scion growth, development, fructification and adaptability of scion on different climatic condition is not yet completely understood.

In the last 20 years different studies were made in the aim of improving knowledge about rootstock influence upon scion's growth and fructification:

- by reducing the internodes lengths on scion extension shoots
- by changing branch angle and tree habit
- by altering the duration and rate of active extension shoot growth on the scion
- by limiting water and mineral elements absorption
- by changing assimilate partitioning in the scion
- by altering equilibrium between production of plant hormones and their transport through rootstock and scion.

The research in this field showed that, generally, the height of grafting at fruit trees is used for limiting the vigour of trees (apple tree, pear tree and plum tree) and as well as a way opf controlling the disease produced by *Pseudomonas Syringae* in plum and apricot trees.

Having as premises that the influence of the rootstock on the scion's characteristics is intensified when the grafting height grows, this study has the following objectives: study of some

anatomy-morphological, physiological and biochemical aspects of scion-rootstock interaction in conditions of height grafting in order to establish a biological database for optimizing technologies of fruit trees planting material production.

In order to attain this aim, the following objectives must be reached:

- Evaluating the success of the grafting process and buds' resistance at freezing in apple, pear, apricot, plum and cherry trees on two different rootstocks with variable characteristics, at 10cm, 20cm, 40 cm.
- Study of the influence of the height grafting on the dynamics of the growing and development process during the vegetation period
- Quantification of the rootstock influence on the biomass accumulation process
- Analyzing the physiological and biochemical changes that appear in the carbon metabolism in the studied species according to used rootstock and height grafting.

The following activities were put into practice:

- evaluating the grafting success percentage and survival percentage of buds over winter in trees grated at various heights
- quantifying the length of the shoots and the total height of the trees
- measuring the diameter of the trees 5 cm below and above the grafting area and 50 cm above soil surface as well as the surface of trunk cross-sectional area
- quantifying the leaf area according to height grafting
- leaf dry substance quantification in trees grafted on different rootstocks at 10cm, 20 cm and 40 cm during their vegetation period
- assimilating pigments and soluble sugars' analysis in leaves, during the vegetation period
- analysis and correlation of results in order to agrobiological argumentation of technological steps in fruit tree planting material production

This doctoral thesis has 236 pages, containing 74 tables, 81 figures and color photographs, conclusions and references with a number of 2 59 titles.

Chapter I presents a short history of the fruit tree planting material production, nationally and internationally, underlying the trends already existent in the domain of rootstock production in apple, pear, plum, apricot and cherry trees, and the improvements that can be made for each fruit tree variety in particular.

Chapter II presents the biological bases of fruit tree grafting and peculiarities in fruit tree material production for the above mentioned species.

Chapter III summarizes the present state of research nationally and internationally concerning the technology of fruit tree planting material production with references of researchers starting 1966 until 2007. Anatomo-morphological, physiological and biochemical

aspects are relieved regarding scion-rootstock interaction, as well as influence of height grafting modifications on fruit trees growth and development (both in nursery and orchard).

Chapter IV presents ecological conditions where the researches took place, reaching the conclusion that Iaşi region, with an optimum thermic potential (in 2000-2008 multi annual average temperature of 10.5 ^{o}C, multi annual average precipitation of 610.2mm/year) is favorable for the five species took in study.

Chapter V presents biological material used, research methods used, chemical analysis biometric measurements, determinations and observations that were made.

In this experiment biological material is represented by apple tree, pear tree, plum tree, apricot tree and sweet cherry tree.

Each of this species was representing by one variety grafted on two different rootstocks at 10 cm, 20 cm and 40 cm above the soil level. Florina apple variety was grafted on MM106 and M9 rootstocks, Untoasă hardy pear variety was grafted on *Pyrus sativa* (Harbuzesti) and *Cydonia oblonga* (BN 70), Stanley plum variety was grafted on *Prunus cerasifera* and *Prunus domestica* (*Renclod verde*), Goldrich apricot variety was grafted on rootstock belonging *Prunus armeniaca and Prunus cerasifera species* and for Bucium sweet cherry variety rootstocks were represented by *Prunus mahaleb* and *Prunus avium* (Bigarreau Jaune Dönissen).

For accomplish the aims and for obtaining of some sustainable scientific results, concerning height grafting influence on rootstock-scion interaction at some fruit tree species biometrical techniques were used and physiological and biochemical analysis were made. The observations were made during 2007-2009 years.

In the nursery height grafting influence on rootstock-scion interaction was observed and recorded by biometric measurements, and in laboratory – by physiological and biochemical analysis.

Biometric measurements and determinations pointed scion shoots length, total fruit tree length, trunk diameter (measured with caliper at 2 cm above and under grafting area, as well as 50 cm above the soil level), trunk cross sectional area at 50 cm above the soil level, ratio between scion diameter and rootstock diameter, average number of leaves from one shoot, average number of anticipated shoots from one tree, average area of one leaf (using gravimetric method with measure of paper contour) and average of fruit trees leaf area.

Physiological analysis followed the quantitative determination of assimilating pigments and total dry matter during the period in which the photosynthetic capacity of tree was maxim (June-August).

Biochemical analysis had in view the determination of soluble sugars from the height grafted fruit tree leaves during the period June –September in the aim for study the biosynthesis and transport process of these compounds in height grafting conditions.

Both physiological and biochemical determinations leave probes were harvested monthly at the same hour of the day, from median tierce of the scion shoot.

In chapter VI are presented the results of research made for accomplish the proposed aims. The biometric measurements showed that grafting success depended more on rootstock - scion association, grafting height influence being strong only the bud over -wintering was determined. The biggest losses were recorded when 40 cm graft was used especially on the small vigour rootstocks.

Rootstock influence on the length of scion was observed at all the spec ies took into the study, the rootstocks with a grater vigour inducing a bigger growth of the shoots comparing with smaller vigour rootstocks. The smallest values of the scions length were recorded at pear tree and apple tree, (especially when M 9 was used as rootstock).

In all the cases, increasing height of grafting leaded to a reduction of the scion shoots length correlated with vigour of the rootstock, so that utilization of rootstocks with a smaller vigour determined a grater reduction of scions length . Therefore we can affirm that limitation of scion shoots by increasing the height of grafting depends in a big measure of rootstock vigour.

Height grafting leaded also on both rootstock and scion stem diameter reduction in all studied variants. Exception makes the apricot specie grafted on *Prunus armeniaca*, where the values of this parameter grows up, or remain relatively constant in the case of grafting on *Prunus cerasifera*.â

In all the variants, along with increasing of grafting height, stem diameter (measured at 50 cm above the soil level) records a descendent tendency, exception making the variants: pear grafted on quince, and sweet cherry grafted on mahaleb. Scion / rootstock stem diameter ratio recorded grater values as long as grafting height was i ncreased from 10 cm to 40 cm. However exception makes the variant represented by Goldrich apricot variety grafted on *Prunus cerasifera* which, along with increasing the height of grafting records a reduction of scion rootstock stem diameter values because o f some thickening of rootstock faster then scion.

Trunk cress sectional area, measured at 50 cm above the soil level increased with increasing of grafting height at all the variants took into the study excepting variants of pear grafted on *Cydonia oblonga* and sweet cherry grafted on *Prunus mahaleb.*

Average number of anticipated shoots/tree varied with specie and rootstock used. Increased values of this parameter along with increasing of budding height was record at pear

tree, plum tree, sweet cherry tree, apricot tree grafted on *Prunus armeniaca*, but, at apple tree and apricot tree grafted on *Prunus cerasifera*, anticipated shoots number decreased.

Once with increasing of budding height, average of leaf area increased at apple, pear and apricot fruit tree species and decreased at the other species function of the used rootstock.

Analyzing the fruit tree leaf area in height grafting conditions, it can be observed the same "picture" as in case of variation of leaves number /tree. At apple and pear trees tot al leaf area decreased, and at plum, apricot and sweet cherry trees values of this parameter increased with increasing of grafting height.

Regarding the leaves dry matter contain, the values of this parameter increased with increasing the height of grafting, according to the used species and rootstocks. The quantitative differences determined by the rootstock decreased with increasing of budding height at apple and pear tree, and increased with increasing of budding height at plum apricot and sweet cherry f ruit trees.

At all studied species, grafted at 20 and 40 cm, a bigger quantity of soluble sugars was recorded in leaves, comparing with control variants grafted at 10 cm, a significant influence of rootstock on this process being observed.

Total quantity of assimilating pigments increased easily with increasing of budding height, at all variants took into the study. Increasing of budding height determined a significant modifications of the chlorophyll a contain, quantitative differences being genetically de termined by the specie and rootstock. However, in August, at some variants (*Untoasă hardy/Cydonia oblonga*, Stanley/ Prunus domestica, Goldrich/ *Prunus cerasifera*, Bucium/ *Prunus avium* şi Bucium/*Prunus mahaleb*) some increases of this parameter values were recorded), at some other variants chlorophyll a values rested constantly (Flor ina/MM106, *Untoasă hardy/Pyrus sativa* şi Stanley/ *Prunus cerasifera*), but there were cases when chlorophyll a decreased with budding height increasing (Florina /M9, Goldrich/ *Prunus armeniaca*).

Due to a greater stability comparing with *chlorophyll a*, *chlorophyll b* did not record significant variations, irrespective of budding height.

It has been observed an increasing of carotenoids pigments with increasing of grafting height, at all the variants, greater values being recorded in case of grafting on the in vigorating rootstocks.

Exception makes the trees grafted on MM106 at 40 cm, in which a small decreasing of this parameter values it has been recorded, and *Untoasă hardy* pear variety grafted on *Pyrus sativa* where the carotenoids pigments quantity rest relatively constant irrespective of budding height. As a generally tendency, *chlorophyll a* / *chlorophyll b* ratio has a similar dynamics with

chlorophyll a, varying with increasing of budding height according to the used species and rootstocks.

Chlorophyll / carotenoids ratio decreased at all the species as a consequence of increasing of carotenoids pigments. Exception makes the variants represented by varieties F lorina/MM106 and Bucium/*Prunus mahaleb* grafted at 40 cm, which recorded some increases of the values of this parameter comparing with control variant (grafted at 10 cm).

In the final of these thesis are presented the conclusions and recommendations which revealed the possibility of height grafting as a way to reduce the vigor of the fruit tree grafted on invigorating rootstocks, with advantages which these rootstocks offer in the case of pear fruit trees. At this specie, these techniques utilisation may avo id grafting on quince for obtaining a planting material which can be used in intensive orchards.

At sweet cherry trees increasing the height of grafting was well supported both when the rootstock was *Prunus avium* and *Prunus mahaleb*. So it can be concluded that the height of grafting may be increased even up to 40 cm, but is more recommended in case of grafting on Prunus avium because beside of reducing the scion vigor, the featuring degree is increased.