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DEPARTMAN ZA RATARSTVO I POVRTARSTVO

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Environmentally related cherry root xylem plasticity

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Twinning

- BOKU
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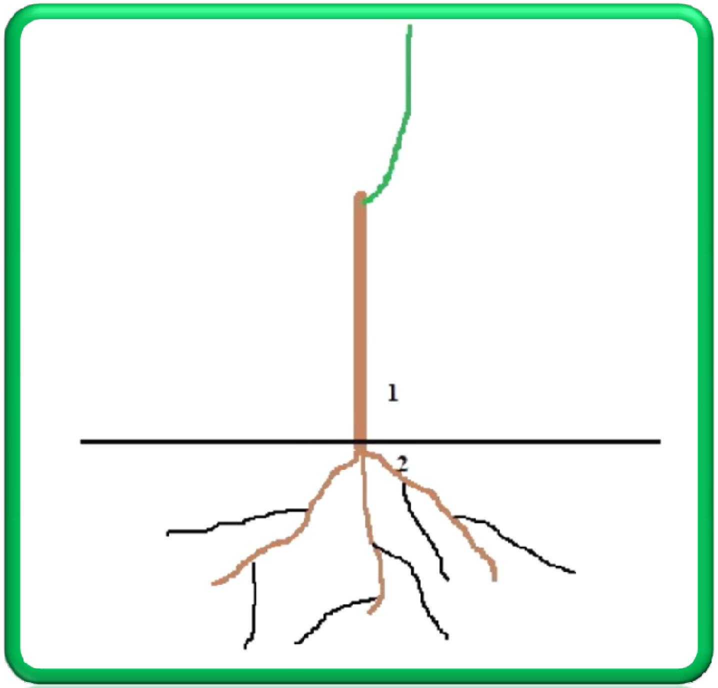
We heard that the most common answers were Experience, improvement, conections...

- Excelent opportunity for inter-institutional conections.
- But what about intra-institutional bounds?
- One of them resulted in many questions and even more answers.

Yesterday there was a presentation regarding ‘well-known’ scion xylem plasticity, but what about the hidden half - root system and it’s cambial and xylem plasticity ?

Rootstock requirements

- Size controlling effect
- Good anchorage
- High compatibility
- High productivity
- Fruit size and quality



Both rootstock parts are equally important – rootstock stem and root system.

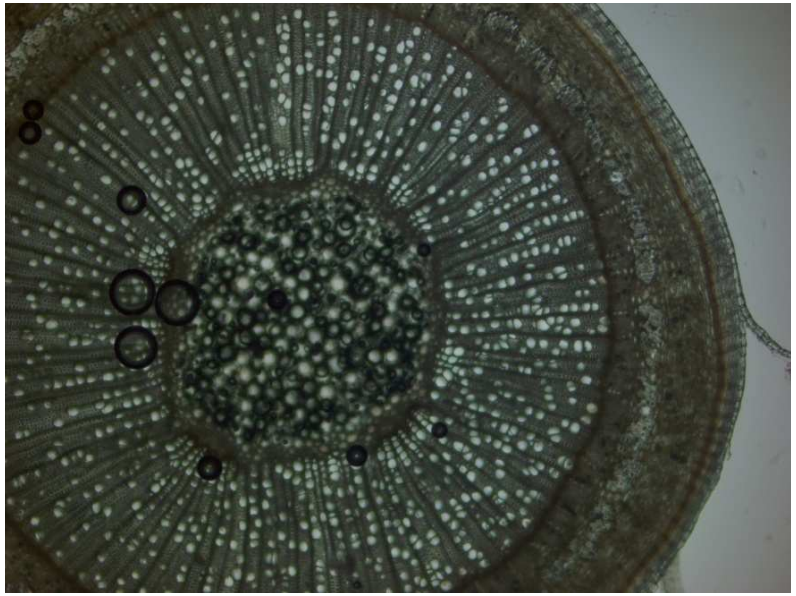
Instead of 10 m tall unmanageable trees – dwarf fruit trees suitable for intensive pedestrian orchards

'Oblačinska' sour cherry/Lara next to the red currant bush

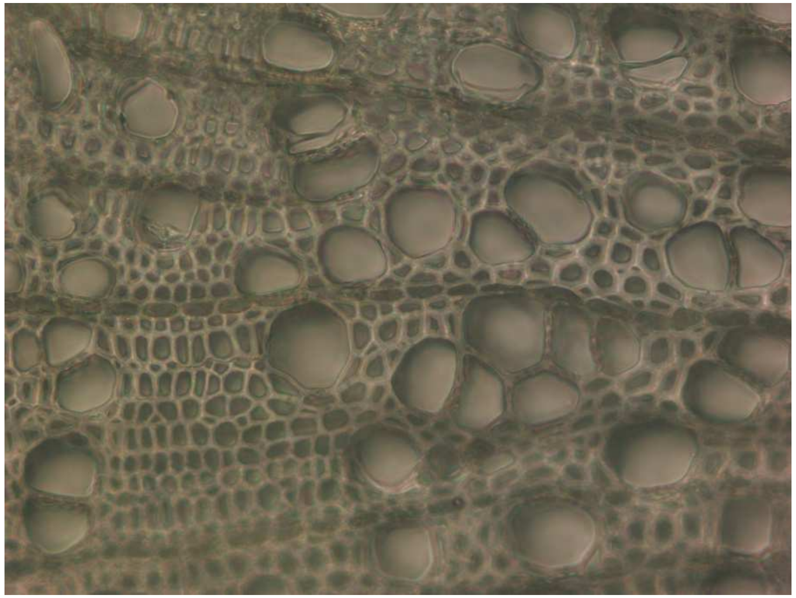
'Oblačinska' sour cherry/Summit

Anatomically assisted cherry rootstock selection

- Macro characteristics



- Micro characteristics



Based on the anatomical measurements, theoretical axial hydraulic conductance is calculated according to the expression given by Tyree and Ewers (1991), based on Hagen-Poisseuille's law:

$$k_h = \frac{\pi \cdot \rho}{128 \cdot \eta} \sum_{i=1}^{n} d_i^4$$

where *d* was the diameter of the vessels in meters, ρ was the fluid density (assumed to be 10^3 kg m^{-3} for water at 20ºC) and η was the viscosity (assumed to be 1.002 10^{-9} MPa s for water at 20ºC).

Important questions that will define good size controlling rootstock

Soil solution uptake and conduction by cohesion-tension theory depends on a complex system consisting of the soil, the plant (rootstock, scion and their interaction) and the atmosphere.

→ *To wich extent do the rhizosphere and atmosphere influence root and shoot formation and xylem characteristics*

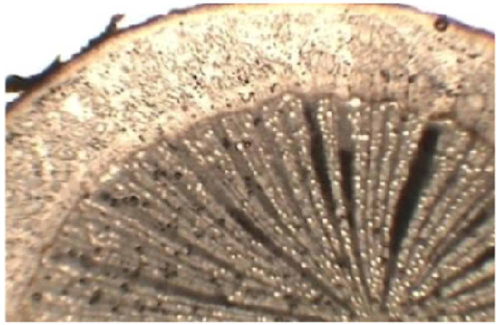
Pertinent literature and results obtained from 2010 – 2016 sugest that the outermost xylem ring is the most responsive for solution axial conductance.

→ *To wich extent do the rhizosphere and atmosphere control root and scion cambial activity?*

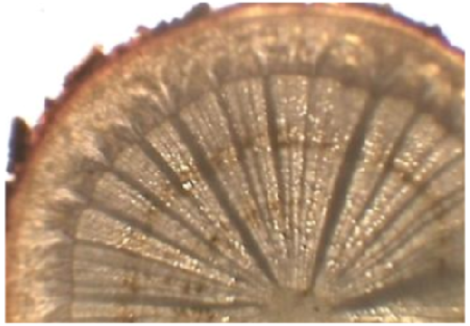
↓

If the cambial activity and new xylem production is mainly driven by the environmental factors, is there any rootstock selection capable to alter xylem vessels size and number.

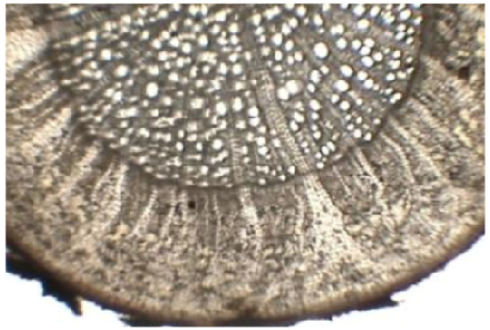
Ring-like formations in one-year-old roots



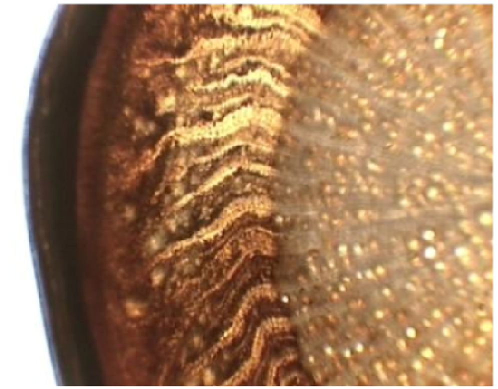
P. fruticosa sel. SV 2



Gisela 5



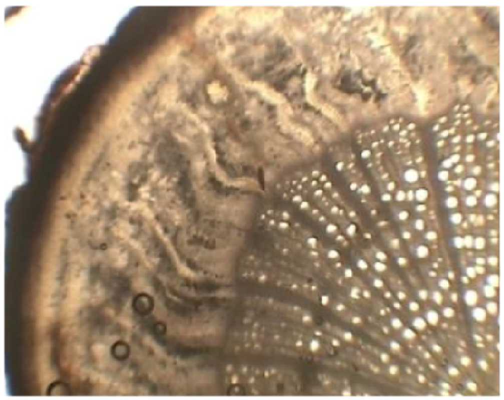
'P. cerasus'OV16



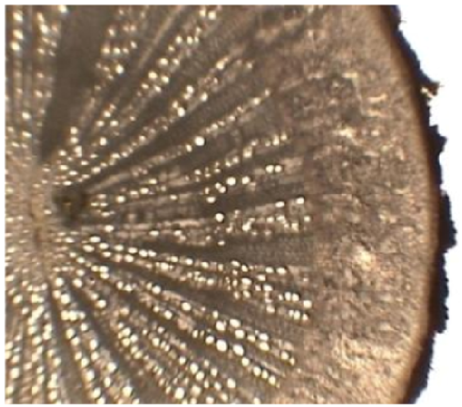
P. fruticosa sel. SV 5

P. mahaleb

'P. cerasus'OV18



P. fruticosa sel. SV 4



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'P. cerasus'OV33

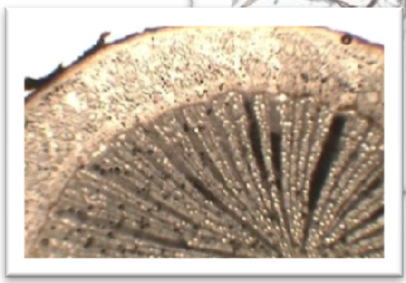
Contrasting sites

Table 1. Sampling locations coordinates and altitudes for investigated cherry species.

Species	Locality	Longitude	Latitude	Altitude
European ground cherry	Fruška gora	19° 55' 01'' E	45° 09' 39'' N	327 m
Oblačinska sour cherry	Dešilovo	21° 37' 35'' E	43° 17' 34'' N	398 m
Oblačinska sour cherry	Prokuplje	21° 32' 54'' E	43° 13' 46'' N	274 m

Contrasting genotypes

European ground cherry

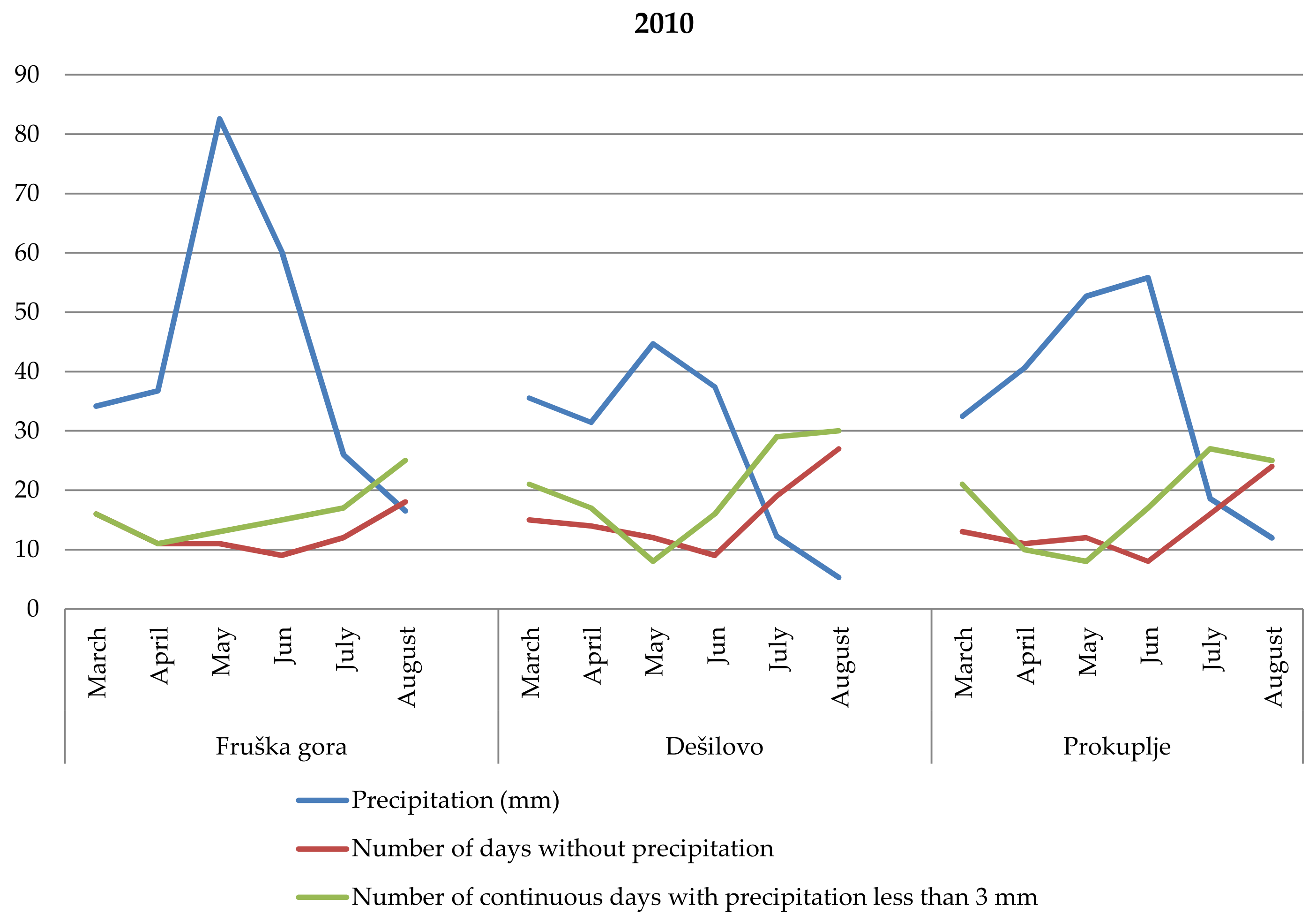


Oblačinska sour cherry

Serbia for Excell

European Commission

Meteorological data – ERA 5



Results

- European ground cherry genotypes were characterized with greater cross section area, with values 27.93±3.70 mm^2 in SV2 and 33.35±10.1 mm^2 in SV4.
- Oblačinska sour cherry genotypes from locality Dešilovo were characterized with far lesser cross section area (from 7.24±3.81 mm^2 in OV18 to 17.52±3.75 mm^2 in OV14), than genotypes from Prokuplje.

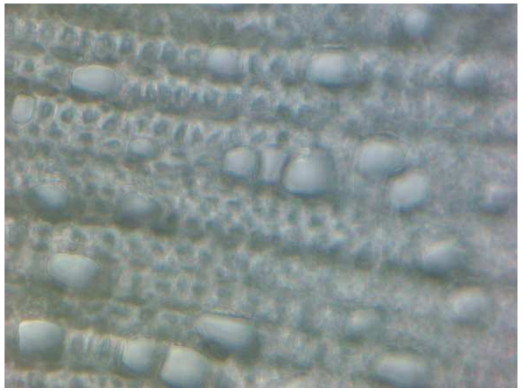
Whole one ring missing in genotypes from Dešilovo

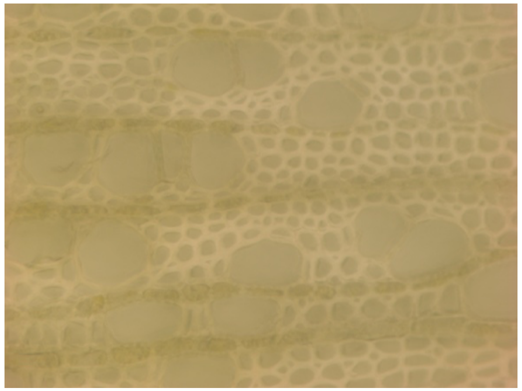
Prokuplje

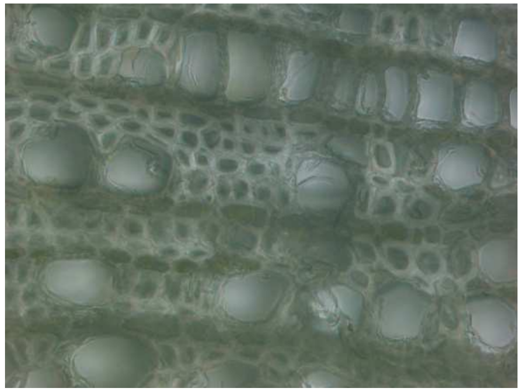
Dešilovo

Results

- European ground cherry genotypes followed typical semi-ring porous pattern - vessel lumen area decreased as the roots matured from 944.40±72.9 μm^2 to 915.93±36.1 μm^2 in SV2 and from 1530.30±1306.70 μm^2 to 1399.15±921.3 μm^2 in SV4
- Oblačinska sour cherry genotypes had very large vessel lumen areas, ranging from 701.38±92.88 μm^2 in OV33 inner zone to 2353.34±676.5 μm^2 in OV16 outer zone


Fruška gora


Prokuplje


Dešilovo

Correlation analysis

- Overall precipitation and its' monthly distribution, as well as monthly sum of temperatures and monthly average temperatures (except for August) were in statistically significant positive correlations with cross-section area, % of secondary wood and wood/cortex ratio, whilst in statistically significant negative correlation with % of secondary cortex.
- Number of dry days during May was in a statistically significant negative correlation with above mentioned cross-section characteristics, whilst in positive with secondary cortex percentage, average vessel number in inner root zone and average vessel number on a complete cross-section area.
- Number of dry days during July and August showed statistically significant negative correlation with all investigated cross-section characteristics (except for secondary cortex percentage that was positive).

Cambial activity did not cease with drought events – very young large vessels were produced during dry days.

Conclusions

- Under environmental signals both investigated species altered their radial root growth **imprinting stops and starts** in cambial activity that resulted in intra-annual false rings occurrence.
- Along the false rings European ground cherry followed the usual early-late wood **pattern**, while oblačinska sour cherry produced larger vessels as an alternative to smaller cross-sections and weaker shallow root system.
- Changing environment conditions triggered the **shifts** of large and small vessels throughout the false rings, but their size seems to be mainly **genetically controlled**.
- For future breeding purposes and size-controlling prediction models development of an equal importance will be the determined environmentally related xylem plasticity as well as genetically controlled conduit size.