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Wurzel- und Sprossentwicklung von Hybridpappeln im Gewächshausversuch
Root and shoot development of hybrid poplars under greenhouse conditions

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INTRODUCTION

German Energy Transition – state of art:
- mix of energy sources
- nuclear phaseout
- research on renewables, e.g. bio-fuels, -gas

Competition for timber – situation on the market
- dramatic increase of (fuel-)wood consumption
- booming pellet market
- "wood supply gap" predicted for Germany

Short Rotation Forestry (SRF)

Advantages:
+ "new" woody crop = agriculture diversification
+ harvest during winter, less activities needed
+ best energy-input to energy-output ratio of all bio-energy crops
+ less or no pesticides or fertilizers needed
+ combined bio-energy / material use possible (cascade of utilization)
+ energy-autarkic (rural) regions possible

Disadvantages:
- high losses of plant material during the phase of establishment due to precipitation-free periods
- only few certified poplar cultivars available

Poplar breeding – current situation:
- beginning domestication of genus *Populus*
- strong need for new cultivars, traits of interest are yield, stability & resistance, specific wood characteristics
- "new" traits: drought tolerance with focus on the early phase of plant development
- need for (new) phenotyping tools: high throughput phenotyping of above- and belowground traits

Objective of the present study
- quantification of above- and belowground biomass development related to water availability
- description of growth characteristics of roots and shoots under drought conditions
- Development of an efficient method for testing young trees

MATERIAL & METHODS

Tree material:
- Except 990 and 930, commercially available hardwood cuttings (maximum 20 cm long and ca. 1.5 cm diameter)
- 7 different genotypes (Max 3, Hybride 275 (also known as NE42), AF 2, Muhle Larsen, Rochester, 990, 930)

Experimental design:
- Greenhouse pot experiment , two levels of irrigation (fully irrigated and deficit irrigated)
- 10 plants per genotype and treatment were harvested at four different intervals after cutting installation
- Duration of the experiment 65 days

Measurements:
- at harvest, plants were dissected into hardwood cuttings, shoots, leaves, roots (Fig. 1)
- determination of fresh and dry weight
- roots were carefully washed, counted, length of the longest root was determined
- root scanning and analysis by WinRhizo Std. 1600+ and WinRhizo Regular V.2002c software (Regent Instruments, Quebec, Canada)

Statistics: software SPSS 22, IBM, Germany

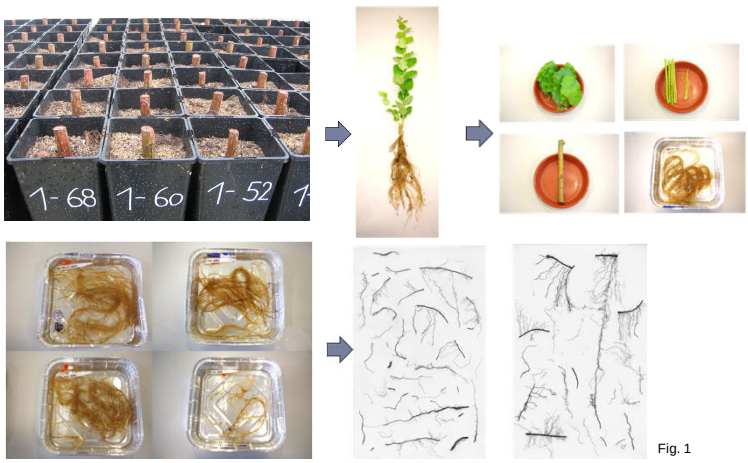

Fig. 1

RESULTS & DISCUSSION

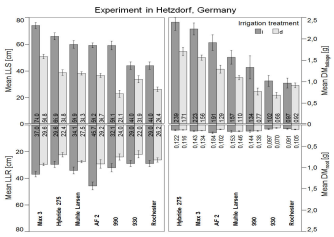

Figure 2: Growth results at the end of the experiment : Mean length of the longest shoot (LLS) and of the longest root (LLR); mean dry biomass of the foliage ($DM_{foliage}$) and of the root system (DM_{root}) of the *Populus* hybrid cultivars at the last sampling date (65 days after planting the cuttings), ordered by mean LLS under normally irrigated conditions. Irrigation treatments: i = normally irrigated, d = droughted. Error bars represent 1 SE.

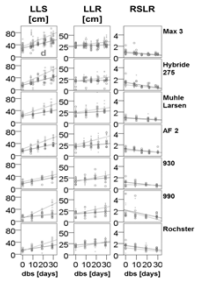

Figure 3: Regression plots for three response variables: Length of the longest shoot (LLS), Length of the longest root (LLR) root-to-shoot length-ratio (RSLR = LLR / LLS). X-axis: days before sampling (dbs) counted from the first sampling date. Light grey lines and crosses: normally irrigated variant (i); dark grey lines and circles: deficit-irrigated, droughted variant (d). The hybrid poplar clone names (*Populus* spp.) are given on the right.

- root length growth reduction under drought is ca. half as large as the reduction of shoot length growth
- Hybride 275 shows a relatively mild reaction on reduced irrigation, indicating a greater plasticity to drought
- AF 2 shows the highest RL, RSA and RV
- Hybride 275 shows the smalles RL, RSA and RV under irrigated conditons, but an increase of RV, which is the result of an elevated proportion of coarse roots (> 4,5 mm in diameter)

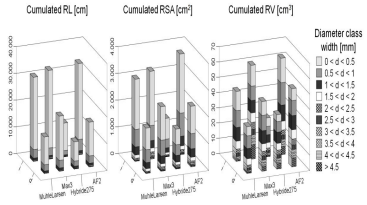

Figure 4: Mean partitioning of the roots into different diameter classes of four poplar clones (*Populus* spp.) under two different irrigation treatments ('i' = normally irrigated, d = 'deficit irrigation'. Left: Cumulated root length (RV); middle: Cumulated root surface area (RSA); right: Cumulated root volume (RV). Sample size per factor level combination = 3.

(Krabel et al. 2015)

CONCLUSIONS & OUTLOOK

1. During the first 65 days of growth, plants cultivated from hardwood cuttings show individual growth characteristics
2. From our results we hypothesize that Hybride 275 accumulates assimilates in coarse roots under drought whereas the other genotypes don't follow this strategy
3. A robust method of high throughput phenotyping of trees seems to be possible

References:
Krabel D, Meyer M, Solger A, Müller R, Carvalho P, Foulkes J (2015) Early root and aboveground biomass Development of hybrid poplars (Populus spp.) under drought conditions. Can. J. For. Res. 45, 1289-1298.

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