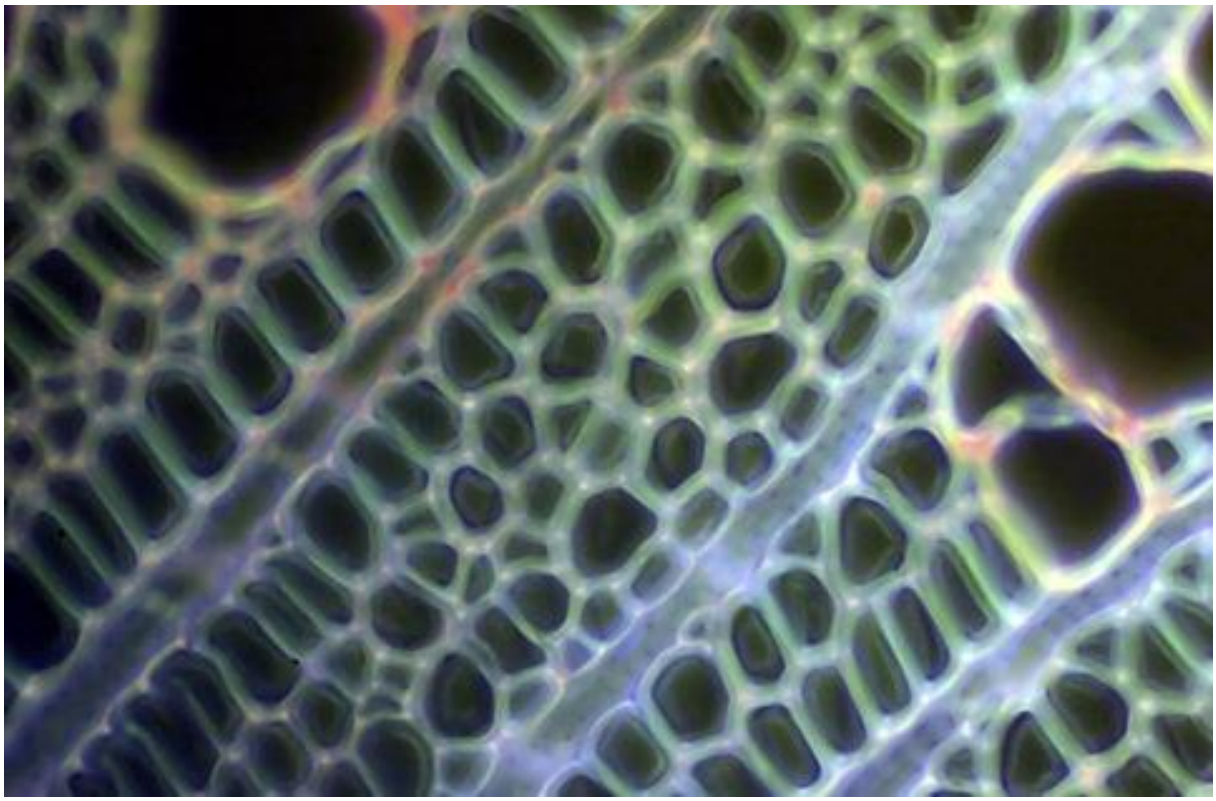
WoodForMS



Wood Formation Mechanisms under Stress

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Context — Wood is an important economic resource valued by numerous industries for its varied uses, particularly as feedstock for bio-energy fuel. Biosynthesis of cellulose and lignin, both important components of wood, is highly controlled during the tree development and are affected by environmental stress factors. Since biomass production increased by elevated CO_2 levels and decreased by high ozone levels, it is particularly important to gauge the impact these two gases have on the mechanisms of wood formation.

Objectives — The project aims at understanding the cellular mechanisms that control the biosynthesis of cellulose and lignin in poplar wood subjected to stress conditions. As the formation of wood depends on the regulation of genes involved in the biosynthesis of cellulose and lignin polymers and the supply of carbon for each, the distribution between these two polymers can be altered by stress.

Approach — Our analysis focus on (i) regulation of cell wall-related NAC/MYB transcription factors involved in the regulation of secondary wall formation and target genes involved in cellulose and lignin biosynthesis; (ii) metabolic control analysis by ^{13}C incorporated into cellulose and lignin as well as carbon distribution among these two polymers.

Key results —

- Cellulose biosynthesis in poplar wood subjected to ozone stress was modified. The ^{13}C incorporation into cellulose was reduced which indicated a decrease in the synthesis of this polymer. The gene expression of 18 cellulose synthase (CesA), UGP and SUSY supplying

substrate for cellulose synthesis, and Korrigan and COBRA for cellulose deposition and crystallinity showed two expression profiles. The transcript abundance of CesA genes involved in the formation of the secondary cell wall, UGP, SUSY genes and members of Korrigan and COBRA gene families were strongly reduced. On the other hand, the gene expression of CesA involved in cellulose synthesis of primary cell wall, and other members of Korrigan and COBRA gene families were strongly induced. These observations suggested a reorganization of the cell wall architecture. Five transcription factors, WND / MYB / KNAT7, showed a similar expression profile to that of CesA of the secondary cell wall. These transcription factors were regulated in response to stress.

- Under elevated CO_2, the ^{13}C incorporation into cellulose was increased, which suggested a stimulation of cellulose synthesis; however, the transcript abundance of genes, cited above, was unchanged or was slightly reduced.
- The two gases in combination had an intermediate effect. Elevated CO_2 seemed to mitigate the ozone effect.
- The reduction of cellulose content must be connected to the content of lignin. Cellulose / lignin ratio was decreased whatever the stress, in spite of the differences in ^{13}C incorporation between ozone and elevated CO_2 stresses.

Main conclusions including key points of discussion — Wood formation was altered under ozone stress. Modifications observed in the secondary and primary cell wall biosynthesis suggested a reorganization of the cell wall architecture. Transcription factors which control wood formation were regulated in response to ozone stress. Cellulose / lignin balance under stress conditions will determine new wood characteristics.

Future perspectives — From these results we plan to: (i) establish a network of gene regulation under stress conditions (RNAseq strategy); (ii) search for genes controlling cellulose / lignin balance (iii) assess the impact of carbon allocation to the stem on the control of cellulose / lignin balance.

Valorisation —

Presentation

Tree Biotechnology 2015 Conference, Florence, Italy, June 2015.

Poster

10^{e} Congrès du Réseau Français des Parois, Amiens, France, Juillet 2014.

Lignin 2014- Biosynthesis and utilization, Umea, Suède, Août 2014.

GDR 3544 Sciences du Bois, Champs sur Marnes, France, Novembre 2013.