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Salix alba and Populus nigra seedlings resistance to physical hydro-sedimentary stresses: nursery experimental approach compared to in situ measurements

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In Europe, riparian Salicaceae is declining following the loss of potential germination areas associated with river management. Nevertheless, as an exception for lowland rivers, the Loire River (France) shows in its middle reaches an efficient sexual regeneration of Populus nigra and Salix alba species on bare sediments deposited during flood events.
The study focuses on the influence of flow, sediment dynamics and fluvial maintenance operations on the establishment and survival of black poplar and white willow seedlings during the first year of development in a lowland sandy-gravel river, the Middle Loire. Main questions are: what is the influence of morphological and sedimentary features on seedlings recruitment and how do they withstand the hydro-sedimentary stresses occurring during high flow periods? How fluvial management works, and induced morphology and sedimentary features, modify the sediment dynamics and subsequent establishment and maintenance of seedlings?
To answer these questions, we developed an ex-situ approach which allowed, under controlled conditions, to determine the influence of the sedimentological characteristics of the substrate on the development and maintenance of seedlings with a specific focus on the root system. Three experiments were carried out for three sedimentary mixtures from the river (sand, sand-gravel and 0.2 m of sand superimposed on sand-gravel mixture) that correspond to grain size and stratigraphy conditions often observed on bars and secondary channels in the Loire.
The experimental design includes 108 plots of 1 m3, with 400 seeds per plot (corresponding to the Loire density measurements) and combining seeds from two species, three sedimentary mixtures, four replicates and three experiments. Experiment 1 (control) is based on the architecture of root systems using the WinRHIZO image analysis software. Experiment 2 is relative to the evaluation of constraints leading to “uprooting” of seedlings. Experiment 3 provides data on the seedlings survival once buried during a flood event. Genetic diversity of the seed lots will be investigated via biomass and shoot / root ratio.
Results reveal that willow seedlings have a higher density of roots compared to poplar. In sand mixture, poplar has a taproot system; in sand-gravel mixture, taproot is divided into several roots which leads to a branched root system. The required forces to uprooting are twice much important for sand-gravel mixture.
In situ measurements detail the sediment dynamics and morphological evolution during and after floods (topography, scour/fill processes, grain size surveys, flow velocity, sediment transport rates) on a managed alluvial bar. Results associated with floods occurring after fluvial management works highlight the rapid regeneration of bedforms associated with sedimentary and hydraulics constraints. This leads to the development of new morphological and sedimentological units, suitable for seedlings recruitment. Thirty plots measurements of seedlings (densities and species) established were associated with these news physical conditions over the bar. Black poplar and white willow appeared for a wide range of grain sizes and on specific morphological units. Seedlings survival will be analyzed with regard to physical constraints determined for each plot from measurements of hydro-sedimentary dynamics and then compared to ex situ results.