**Resilience from perturbation of architectural scheme through planting varies largely in Pinus pinaster**

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**Introduction**

Planting is a widespread propagation technique for woody plants. Container-growth and plantation is likely to heavily alter root architecture and thus modify anchorage. The Landes forest is located South-West France and produces 20% of french wood, it is mainly composed of intensively managed even-aged stands of *P. sylvestris* (Danjon & Reynolds 2008). Root system tropism is a key component in mechanical stability of trees. In their first 15 years, pines are mainly anchored by a rigid vertical and deep taproot (Danquechin Dorval 2016). Older trees are anchored by a rigid cage mainly composed of regularly spaced shallow shallow roots from which branch secondary sinkers (Dangor et al. 2005). The main framework of the central part of the root system is established at 4-years-old with a clear identification of root types (Saint Cast et al. 2020).

In this study, we characterize the deformations of root systems of *P. pinaster* saplings grown in containers and planted in the field. Incidence on root system architecture is analysed.

**MATERIAL AND METHODS**

Three hundred 3 to 5-years-old *P. pinaster* saplings planted in 16 forest stands were uprooted with hand tool and digitized using a magnetic field Polhemus 3D digitizer (Danjon & Reynolds 2008). They were compared to 30 direct seeded trees from one stand. The resulting database contained 67000 segments and 10250 axes. We set up and used an original architectural analysis to characterise deformations and thus root type modifications in order to examine the resulting root architecture and potential stability.

**RESULTS**

**Stump-taproot axis**

The root system of planted trees was 1.8 cm deeper on average than seeded trees, few plugs showed on the soil surface or were crushed. Plug tortuosity averaged 14% in the planted trees and 5% in the seeded trees, below plug and soil zone tortuosity was weak. In the below-plug zone, vertical deviation of the first order root peaked at a 40° average vs. 20° in the seeded trees (fig 5). Overall, 37% of planted trees have a non vertical taproot vs. 1.5% for the seeded (fig 6). When the taproot was not vertical in the 4 cm long below-plug zone, 30% of the taproots did not recover their verticality. Conversely, only 7% lost it when the below plug zone was vertical (fig 7).

**Coarse roots, from juvenile to mature stage**

The distribution of these roots along the first order root was maintained in a non-horizontal position, 27% of these originally horizontal root was maintained in a non-horizontal position, 27% of these originally horizontal root was modified by container planting and the largest ones grew from the upper plug zone. Heavy deformations of laterals due to nursery growth in comparison to the direct way (fig 8). When significantly different from the seeded control (C)

**Potential shallow roots**

The distribution of these roots along the first order root was not modified by container planting and the largest ones grew from the upper plug zone. Heavy deformations of laterals due to nursery growth in comparison to the direct way (fig 8). When significantly different from the seeded control (C)

**Conclusions**

The studied planted stands showed low mortality and a number of badly planted seedlings. They displayed a very large variability in type and degree of deformations which could not be related to variables like the planting season or the type of soil preparation. About half the planted trees showed a good resilience as they were able to grow a root system which is

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