# Comparison of ingrowth bags and ingrowth meshes in root studies: 3 years of data on Pinus pinaster and its understory

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## Comparison of ingrowth bags and ingrowth meshes in root studies: 3 years of data on *Pinus pinaster* and its understory

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**Abstract**

Assessing root production and turnover of carbon and or nutrients through roots is still a challenging task, yet primordial to reach full understanding of biogeochemical cycles in many ecosystems. In recent years ingrowth meshes have been proposed as a further tool to study root production and turnover, next to more classical methods as sequential coring, ingrowth bags or minirhizotron methods.

In this study, we applied flexible mesh material (6 mm mesh size) in *Pinus pinaster* production forests in southwestern France, featuring the following 5 dominant understory species: *Cytisus scoparius*, *Calluna vulgaris*, *Erica cinerea*, *Pteridium aquilinium* and *Molinia caerulea*. Four stands for each combination of dominant understory and *Pinus* were investigated throughout the study. The mesh material was either applied as bags (8 cm diameter, 15 cm deep, filled with soil from each site, topped with a litter lid) or as 50 cm long meshes (put with spades down to 15 cm in the soil, topped with litter). Harvests were carried out after 9, 24 and 36 months. For each sample roots were separated according to species, diameter class ((<0.5, 0.5–1, 1–2, 2–5, 5–10, 10–20 and 20–50 mm) and vitality (live or dead). Measured or derived root parameters considered include number of roots (mesh only), fine root biomass, fine root length, fine root density, specific root length, branching (number of apices per m of root length, for *Pinus* only), live fraction and for fine roots percentage of roots in a given diameter class (relative to all roots <2 mm). In order to compute these parameters for the meshes we considered a hypothetical volume of 2.5 cm on either side of the mesh times 50 cm length and 15 cm height. We expected i) that the ingrowth mesh method would be more suitable in monitoring growth (i.e. production and turnover) of coarser root diameters as a larger mesh surface was available for roots to grow through relative to the bags. Furher, we hoped ii) that meshes would cost less time for root extraction.

Results show for most understory – *Pinus* combinations a higher fine root biomass for understory species than for *Pinus* (with the exception of *Cytisus*), but patterns for fine root biomass over time (9 to 36 months) were similar for understory and pine: increase from 9 to 24 months, then a decrease. Meanwhile, between 24 and 36 months the live fraction decreased (between 90 and 100 % after 24 resp. 9 months, down to 40–60% after 36 months). Total root biomass (live + dead roots) present in both bags and meshes was actually higher after 36 months. Patterns for fine root length and fine root length density were similar to the pattern for fine root biomass. When comparing bags with meshes there seems to be less biomass growing into meshes than into bags for the finest root class (<0.5 mm in diameter). But when considering all fine roots (<2 mm) this is not evident, suggesting that more roots of the coarser fine root classes (0.5-1.0 and 1–2 mm) classes dominate in the meshes. This might point to some delay of soil exploitation of the mesh zone by roots (fewer very fine roots, larger proportion of less fine roots). Specific root lengths, indeed, were rather similar for pine roots in bags and meshes for the <0.5 mm class, but lower in meshes for the <2mm class than in bags. Presumably, the disturbance in mesh zones (upon installation) is higher than for bags: e.g. small roots (2–5, 5–10 or sometimes bigger roots) were found damaged on the outside of the mesh zone, giving rise to many reiterated roots of smaller diameter (1–2, 2–5 mm). This would suggest some bias to the numbers (and properties) of roots of the coarser diameters.

The overall conclusions are:
1. Ingrowth bags and meshes give roughly comparable results
2. Observed differences may be size related (larger volume for colonization, more disturbance potentially). In particular, the method did not, in our case, yield enough exploitable results for small to coarse roots (2 to 50 mm in diameter) and therefore, we cannot conclude that ingrowth meshes are clearly a better method for studying small and coarse roots.
3. Handling ingrowth meshes did not cost less time than handling ingrowth bags in our study.
4. We suggest using smaller mesh surfaces (20 cm?) and of more rigid material to optimize the mesh method as an alternative to ingrowth bags.