Ann. Sci. For. (1989) 46 suppl., 301s-304s
Forest Tree Physiology, E. Dreyer *et al.*, eds.

Fine root growth in a sweet chestnut (*Castanea sativa* Mill.) coppice

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Introduction

The root growth and turnover of fine roots are known to be a major carbon pathway in forest ecosystems (Fogel, 1985). Dubroca (1983) showed that the carbohydrate reserves play a major role in both above- and belowground growth of a sweet chestnut (*Castanea sativa* Mill.) coppice. The aim of this study was to examine fine root phenology of a chestnut coppice with an emphasis on the influence of coppicing.

Materials and Methods

This study took place in a sweet chestnut coppice, 30 km SW of Paris, growing on an illuviated acid soil.

5 vertical rhizotrons, 40 cm wide, 50 cm deep, were built in March 1985, each of them facing a stump of average size at a distance of 1 m. One of them faced a stump entering its 1st year after coppicing (no. 1), 2 others faced 5 yr stumps (nos. 5 and 5'), and the last 2 faced 16 yr stumps (nos. 16 and 16'). As soon as the first roots appeared, root growth was recorded weekly until early August and then every 2 wk until November, by means of mapping all roots visible behind the glass on a transparent plastic sheet. A distinction was made between long roots and laterals, the former being defined as the ones bearing the latter.

Results

The patterns of fine root growth in the older coppices (5 and 16 yr coppices) can be divided into 4 overlapping phases.

Phase I: initiation of long roots (June)

This phase began when the first roots appeared in early June, *viz.* 1.5 mo after bud burst, and was completed in late June: the destruction of roots during that period in rhizotrons 5' and 16', when a rodent dug a gallery behind the glass, prevented the root system from fully developing until the end of the growing season (Fig. 1). Since the destroyed roots were not replaced after that period, it appeared to be critical.

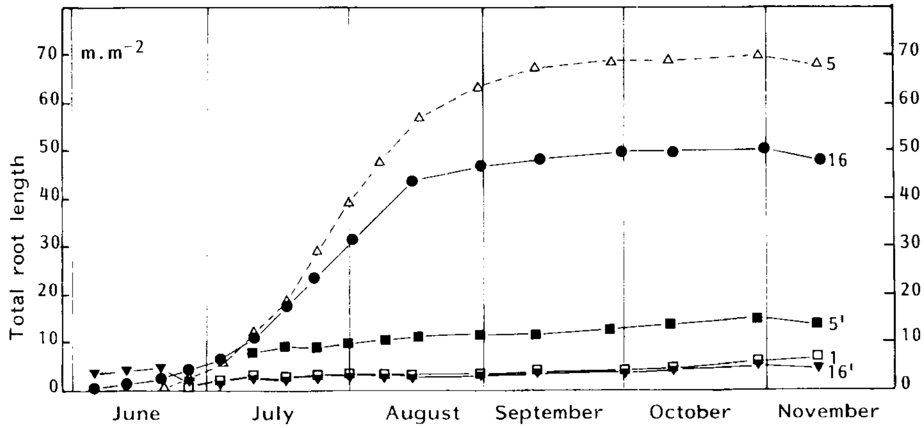

Fig. 1. Evolution of total root length.

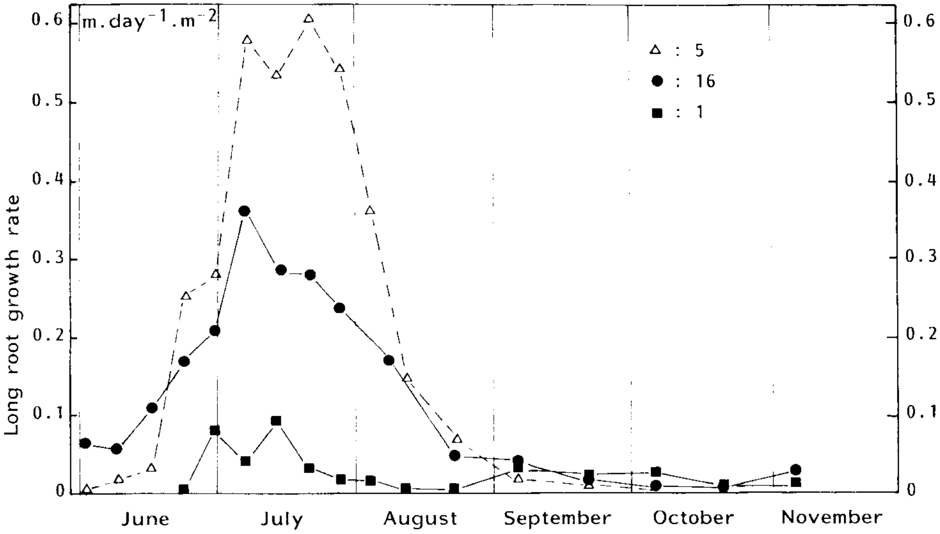

Fig. 2. Evolution of long root growth rate.

Phase II: setting up of the long root network (mid-June to late August)

The long root growth rate was high from June to August with a peak in July. From September to November, the long root growth was residual (Fig. 2): the complete development of the long root network was finished in late August.

Phase III: setting up of laterals (July to mid-September)

The rate of appearance of laterals growing acropetally along the unbranched parts of the long roots followed a pattern similar to the one of the long root growth rate with a delay of about 3 wk (Fig. 3). The setting up of the laterals, *viz.* the absorbing root

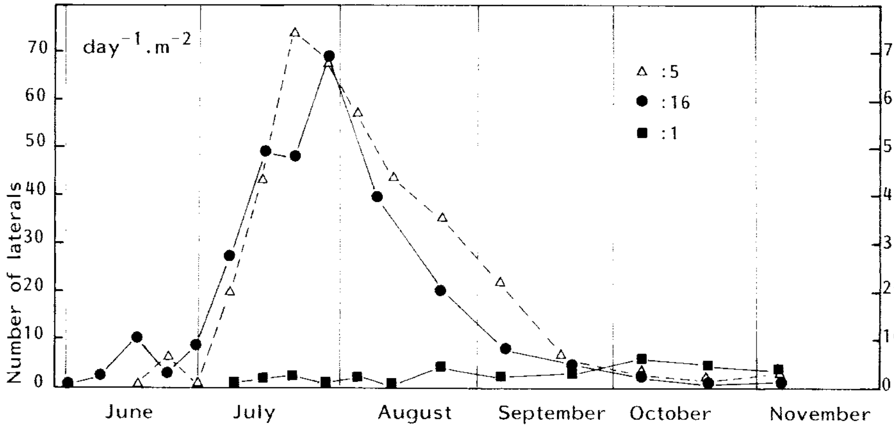

Fig. 3. Number of laterals appearing on unbranched long roots.

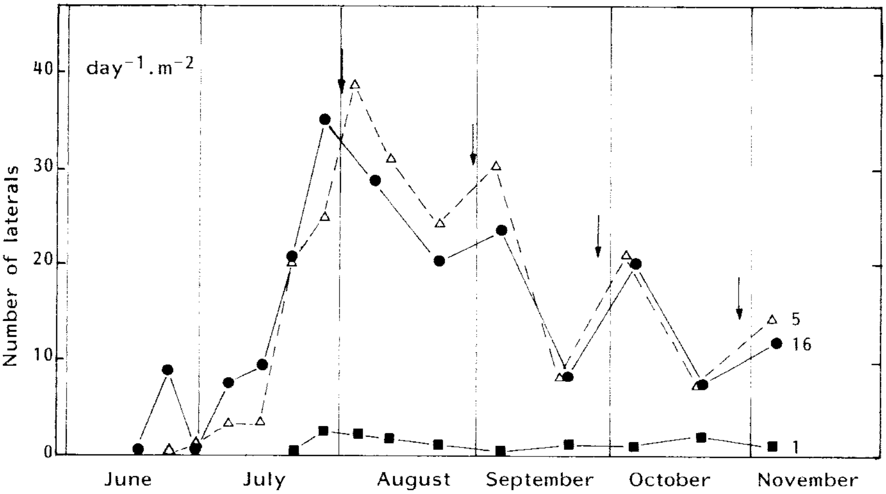

Fig. 4. Number of laterals appearing on branched long roots. (Arrows = rehydration of the soil.)

system, occurred therefore from July to early September, when it was completed.

Phase IV: maintenance of the absorbing root system (July to September)

The rate of appearance of laterals on already branched parts of long roots increased until late July as the long root system developed and then decreased until November (Fig. 4). It remained relatively high in autumn in contrast to the laterals appearing on unbranched long roots. This kind of lateral seems to respond positively to soil rehydration (arrows Fig. 4). Stabilization of total root length in autumn (Fig. 1) was the result of the domination of phase IV which compensated for mortality.

The first year coppice did not follow this pattern, since the development of long roots and therefore of laterals was weak throughout the growing season (Figs. 2 and 3). There is some evidence of a compensating development of long roots and laterals in autumn. However, it was not enough to compensate for the delay in growth compared to the older coppices (Fig. 1).

Discussion and Conclusion

In the older coppices, root carbohydrate reserves are directed to root growth, and shoot reserves to shoot growth in the spring (Dubroca, 1983): there seems to be no competition for carbohydrates between shoots and roots. In the first year coppice, the shoot reserves are removed and the root reserves have already been depleted by shoot growth when root growth resumes (Pontailler *et al.,* 1984): the lack of carbohydrates prevents root growth from occurring at the normal level.

Root growth slows down in autumn when the root reserves are replenished. The replenishment of root reserves occurs later in the first year coppice than in the older ones (Dubroca, 1983). A small amount of photosynthates is then directed to root growth in the former when shoot growth has stopped in autumn and before the replenishment of root reserves. A compensatory growth of roots may then occur in autumn in the first year coppice.

References

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