Advantages and drawbacks of fertilisation in short rotation forests

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Willows are often used in short rotation forestry (SRF) in northern region. In most cases, the harvestable yield (i.e. wood) of SRF is used as a renewable source of energy. Fast growing species like willows have high nutrient demand. Production is usually limited by nutrient availability. In order to increase production of SRF either commercial mineral fertilisers or municipal sewage are used. Both fertilisation options cause economic expenditures. The influence of fertilisation on wood biomass production is different in different clones. Therefore the possible benefit of additional fertilisation has to be evaluated carefully. The aim of this study is to evaluate the advantages and drawbacks of fertilisation in order to achieve stable and optimal yield.

Leaf production of fertilised willows was much higher than that of non/fertilised plants. In 1997 there was about 240 g of leaves (dry weight) in 1 m2 of non-fertilised plot. The fertilised plot of the same plantation was 350 g of leaves per m2. Fertilisation increased leaf area index up to 3,5 times

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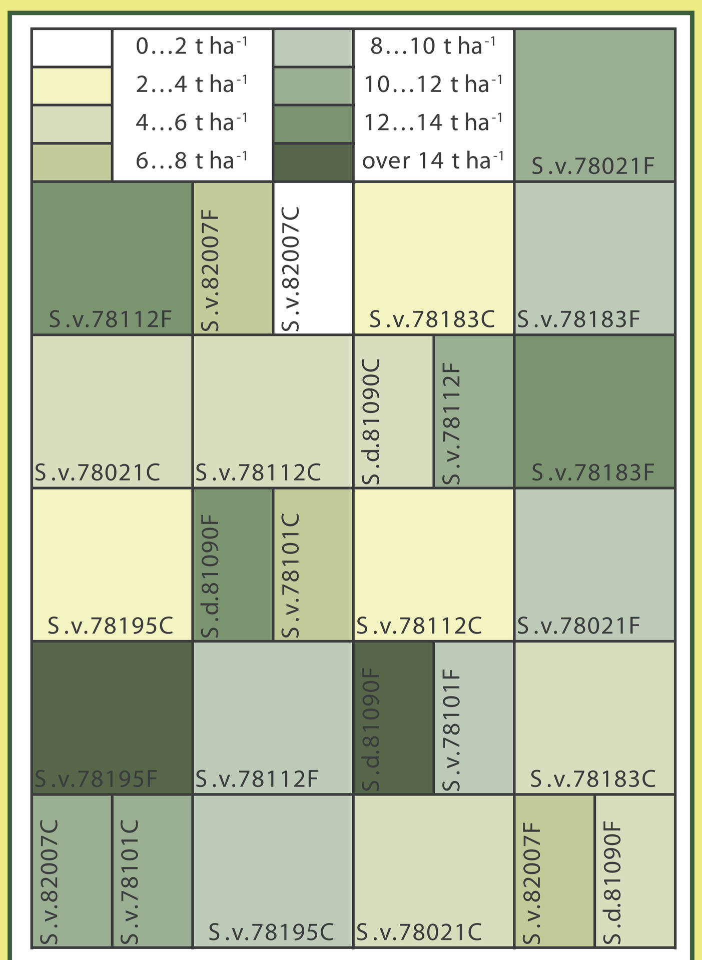

Figure 1:
Average annual wood productivity of willows in Saare plantation during 1994-1997.
Clone numbers correspond to the Swedish clone numbering system.
S.v. – *Salix viminalis*; S.d. – *Salix dasyclados*; F – fertilised plots; C – non-fertilised plots

During the first rotation cycle, large production variability between different clones/nutrient conditions was found in our plantations (Fig. 1).

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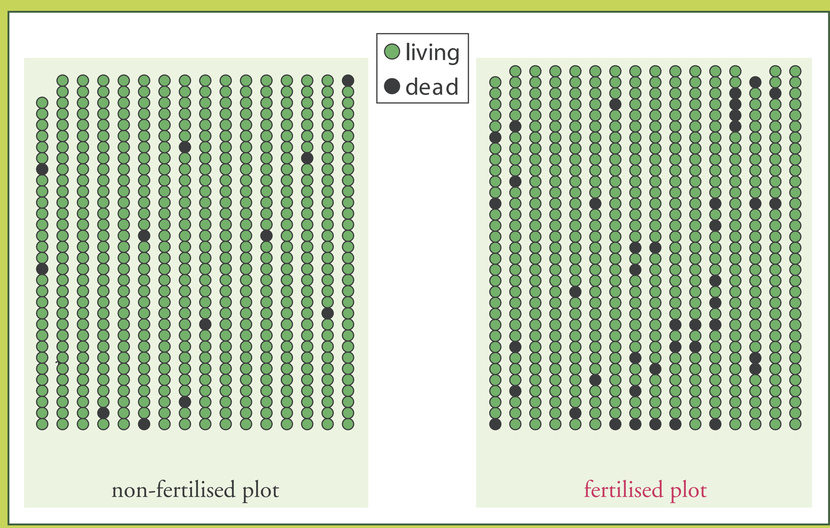
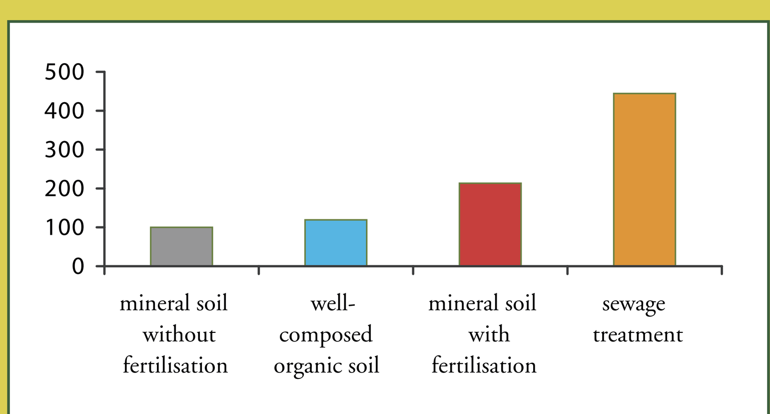


Application of mineral fertilisers increased the average annual wood production about twice, wastewater treatment in a surface-subsurface vegetation filter with almost unlimited nutrient and water supply increased wood production over four times.
Enhanced nutrient supply changed considerably the partitioning of biomass between above- and below-ground organs. In the fertilised plots the transpiring surface per unit of fine root mass was therefore several times higher than in non-fertilised plots (Fig. 3).

2



Despite differences in natural soil fertility, the variability of production in non-fertilised plantations was small (Fig. 2).

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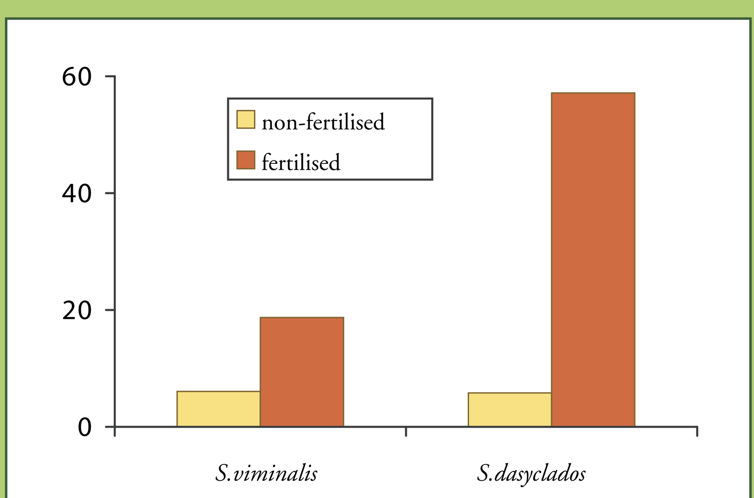

Increased sensitivity to frost damage and water stress may be one reason for higher stool mortality of fertilised plots compared to the non-fertilised ones.
In the second year of second rotation period (1999) stool mortality in fertilised plots was 7…29%, in non-fertilised plots – 2…17% (Fig. 4).

We conclude that in the region with short vegetation period, fertilisation is the only possible way to make SRF economically profitable. The increased risk of drought damage and frost, caused by fertilisation could be diminished by careful choice of less sensitive planting material and by optimal use of fertilisers. The usage of wastewater has dual effect on SRF growth: additional fertilisation and avoidance of drought. In this case the application rate of nutrients can be much higher compared to the usage of mineral fertilisers only in order to take the advantage of the growth potential of willows. However, the water supply must be stable. In the case of occasional interruption of water supply the heavily biased leaf/root ratio may cause rapid drought damage.

In the second half of first rotation period the annual fine root production of fertilised willows was significantly smaller than that of non-fertilised plants. Root production can be measured with the help of ingrowth cores. The ingrowth cores were inserted vertically into the soil and filled with root-free soil from the same location/horizon. In autumn the ingrowth cores were carefully extracted with the corer.

Material and methods:

The studies were performed in three Estonian SRF plantations established in 1993-1995. The planting material consisted of 7 clones of *Salix viminalis* and *S. dasyclados*, selected for SRF within the Swedish Energy Forest Programme. All study sites have been described in detail earlier. Saare plantation (0.6 ha) is located on sandy mineral soil and divided into 30 plots, planted with 7 different Salix clones. 15 plots were supplied annually with mineral fertiliser. Kambja plantation (0.3 ha) is located on well-composed organic soil and divided into 28 plots. No additional fertilisers were used in this plantation. Aarike plantation (180 m2) is designed as surface-subsurface vegetation filter to purify the wastewater of an elderly home. The amount of wastewater used guarantees almost unlimited supply of nutrients and water in this plantation. Wood and leaf biomass were estimated by using allometric relations between shoot diameter and wood (stem + branches) or leaf dry mass. These relations were determined on the basis of harvested shoots (n= 20 …30) and subsequently applied to the measured shoot diameter data of 20 stools. In the calculations of leaf area per stool, specific leaf area (leaf area/leaf dry mass) was used to convert leaf mass to leaf area. Fine root biomass was estimated by soil coring (ten randomly chosen samples per plot). Soil corer with cutting edge 48 mm in diameter was used to extract samples of 40 cm. All fine roots < 2 mm were manually separated and washed before drying. In order to avoid from possible overestimation of root biomass the ash content of subsamples burnt at 450 ?C was found. In this study we used the data of ash-free dry mass of fine roots.