

Poplar and willow short-rotation coppice response to fertilisation in a lysimeter-based trial. Results of the first rotation

Werther Guidi, Enrico Bonari, Emiliano Piccioni

Land Lab - Sant' Anna School of Advanced Studies, via Santa Cecilia 3 - 56127, Pisa, Italy

INTRODUCTION

The main goal of cultivating SRC is represented by its potential role as a renewable energy source. Currently, biomass production is more typically associated with other additional benefits (i.e. phytoremediation, soil protection, etc.). Several studies have recently focused on willow and poplar SRC growth and productivity, but most of them have never been conducted in lysimeters where plants can theoretically grow under optimal conditions with particular regard to water supply. The lysimeter allows a specific crop to grow throughout the season without risk of water shortage by keeping soil humidity around field capacity. Therefore, growth and biomass production obtained under this condition may indicate the potential for a specific crop. Willow and poplar can be considered the main species of interest that can be grown in north-central Italy, and thus information about the potential productivity of certain species and clones can be of considerable value.

MATERIALS AND METHODS

The research was carried out at San Piero a Grado, Pisa (north-central Italy) (43°N, 11°E; altitude 5 m a.s.l.). Temperature and rainfall patterns for the years of the trial are shown in Fig. 1.

In winter 2002, twelve drainage lysimeters were set up in the field. Each lysimeter was provided with an automatic system that maintained soil humidity around field capacity (Fig. 2). Soil characteristics are shown in Fig. 1.

In March 2003, two 0.2 m cuttings of *Salix alba* (clone SI62-059) and *Populus deltoides* (clone Lux) were planted 0.40 m apart in each lysimeter. In order to simulate the normal density of a SRC plantation (10,000 plants ha⁻¹), further cuttings were planted at the edge of each lysimeter. All the shoots were harvested at the end of the first year.

In order to estimate the effect of fertilisation on biomass production lysimeters were assigned either only tap water (NF) or a solution of N-P (21:21) (F). The annual amount of fertiliser applied respectively for the three years was: 120 kg, 200 kg, and 300 kg ha⁻¹.

Height and diameter, as well as number of shoots per lysimeter were tracked every 15 days throughout the duration of the trial. Biomass production was determined at the end of the establishment year and at the end of the second year after coppice.

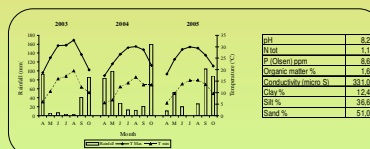


Fig. 1. Meteorological pattern (left) and soil characteristics (right) at the experimental site

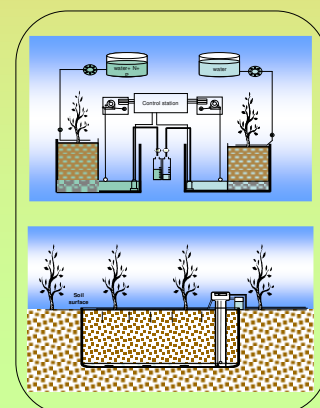


Fig. 2. Scheme of the lysimeter used in the trial

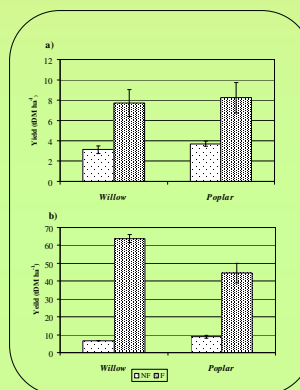


Fig. 5. Biomass yield of poplar and willow for the establishment year (a) and at the end of the first rotation (b). SE in bars

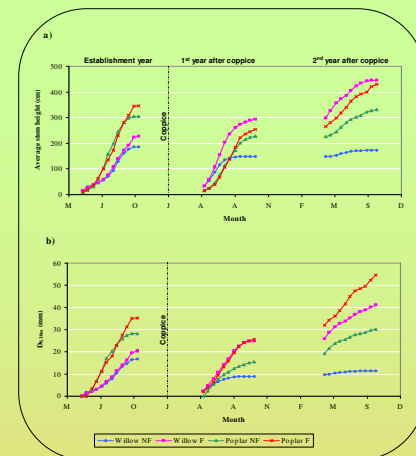


Fig. 3. Height (a) and diameter (b) growth

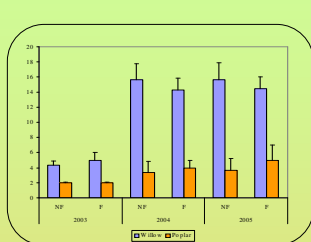


Fig. 4. Number of stems per lysimeter



Parameter	Poplar		Willow		Statistical Fertilisation	Species
	F	NF	F	NF		
Yield 2003 (t DM ha ⁻¹)	8.2	3.7	7.7	3.1	F>NF	P=W
Yield 2005 (t DM ha ⁻¹)	44.4	8.9	63.9	6.6	F>NF	W>P (F)

Tab. 2. Effect of fertilisation on biomass production of poplar and willow for the establishment year (2003) and at the end of the first rotation (2005). Differences (p<0.05) between clones (P,W) and fertilisation (F,NF) are expressed by using comparison symbols (=>)

RESULTS

Establishment year

During the first year, stem height was, on average, higher in poplar than willow for both treatments. It ranged from 305 (NF) to 347 (F) cm, whereas in willow it ranged from 186 (NF) to 229 (F) cm (Fig. 3a). Significant differences were only due to the effect of the species. Average diameters ranged respectively from 28.3 (NF) to 35.4 (F) mm in poplar and 16.7 (NF) 20.4 (F) mm in willow (Fig. 3b). Number of shoots per plant were instead higher in willow (both treatments) than in poplar (Fig. 4). Oven-dry biomass was respectively 3.14 (NF) and 7.72 (F) t ha⁻¹ in willow and 3.70 (NF) 8.24 (F) t ha⁻¹ in poplar (Fig. 5), and differences were mainly due to the effect of nutrient supply.

First year after coppice

At the end of the second year average stem height ranged from 227 (NF) to 254 (F) cm in poplar and 149 (NF) to 294 (F) cm in willow, but no significant differences were found between species and treatments. Diameters ranged from 15.4 (NF) to 25.7 (F) mm in poplar to 8.9 (NF) to 25 (F) mm in willow, showing differences determined by the treatment. Number of shoots per plant was still higher in willow than in poplar, and such differences increased after coppice.

Second year after coppice

Average stem dimensions at the end of the second year after coppice showed a general increase in differences among fertilised and non-fertilised plants. Height ranged between 330 (NF) and 430 (F) cm in poplar and 173 (NF) 446 (F) cm in willow, whereas average diameters ranged from 30.1 (NF) and 54.7 (F) mm in poplar and 11.5 (NF) and 41.2 (F) in willow. Number of shoots per plant did not change and was still depending on the species. Aboveground biomass at the end of the second year was respectively 8.2 (NF) 44.4 (F) t ha⁻¹ in poplar and 6.6 (NF) 63.9 (F) t ha⁻¹ in willow.



MAIN CONCLUSIONS

- Fertilisation positively affected poplar and willow growth and biomass production.
- Nevertheless, at the end of the second year after coppice, the two species showed a different response to different fertilisation levels.
- In terms of biomass yield, under fertilised conditions (F), willow performed better than poplar.