BIOMASS PRODUCTION OF FAST GROWING SPECIES IN A SHORT ROTATION COPPICE IN SICILY (ITALY)

Facciotto G., Nervo G.
CRA – Unità di ricerca per le Produzioni legnose fuori foresta (PLF)
Strada Frassineto Po, 35 I-15033 Casale Monferrato (AL) Italy tel +39 0142330900, fax +39 014255580
e-mail: gianni.facciotto@entecra.it

ABSTRACT: This work reports preliminary results on growth dynamics and biomass production of a SRC trials with poplar, black locust, eucalyptus and Acacia saligna. The plantations were established in three sites in the center of the Sicily: Mussomeli, San Cataldo, and Caltanissetta loc. Misteci. The first trial is located near a municipal waste water treatment plant. Cuttings of poplar clones and seedlings one year old of the other species, were planted in 2008 spring respectively at a density of 6667 and 3333 trees per hectare. Data collection concerned: direct observation (stool mortality) during the growing season and dendrometric recording (number of stools, diameter and height) at the end of each year, wet and dry weight of sample tree at the end of the second years, calorific value of acacia saligna whole trees. The growth performance and biomass production of Acacia saligna appeared to be better than for all the other species in marginal soil and dry condition (annual rainfall about 500 mm) of Central Sicily. Only Eucalyptus, particularly E. camaldulensis, can compete with it in these sites, while Poplar and Black locust are not adapted. The calorific value of acacia saligna was not different than reported in literature for the other tree species.
Keywords: Biomass, production, wood crops, calorific value.

1 INTRODUCTION

In Italy, Short Rotation Forestry (SRF) and Short Rotation Coppice (SRC) were developed specially in northern Regions. The species cultivated in experimental trials and commercial stands, are mainly: poplar (*Populus* spp.), willow (*Salix* spp.), and black locust (*Robinia pseudoacacia* L). Other species, mainly of genus Eucalyptus (*Eucalyptus* spp.) are cultivated in smaller stands in Central and South Italy. To extend SRF and SRC in Southern Italy and to verify the production potential in these environments characterized by low water availability the Ministry of Agricultural, Food and Forestry Policies (Italy) funded some specific research programs: BIOENERGIE and FAESI.

Recently it is assessed that the potential areas of short rotation forestry in Sicily (not irrigated land) could produce about 1.3 Mt of biomass that could be transformed into wood pellets. SRF and SRC potentially might be able to take the place of many of the present marginal agricultural crops [1].

Figure 1: Mussomeli (CL). SRC of Acacia saligna at the end of second growing season.

In order to contribute to a sustainable use of these marginal land and to identify appropriate species and clones for bioenergy production, four field trials were established in three different sites of Caltanissetta province, in the center of the Sicily: Mussomeli (fig. 1), San Cataldo, and Caltanissetta loc. Misteci (fig. 2).

Figure 2: Caltanissetta loc. Misteci. SRC of Eucalyptus.

2 MATERIALS AND METHODS

The trials were established in Spring 2008; all the site are in a hilly regions with a mean annual rainfall of approximately 500 mm. The experimental field of Mussomeli is located near a municipal waste water treatment plant. In this site and in the field of Misteci, poplar (*Populus* spp L), black locust (*Robinia pseudoacacia* L.), eucalyptus (*Eucalyptus camaldulensis* Dehnn and *E. globulus* Labill.) and *Acacia saligna* (Labill.) H.L.Wendl are compared. Different poplar clones (*Populus* spp.), were selected for the establishment of the SRC at both experimental sites of San Cataldo. In one ten *P. deltoides* Marsh. and *P ×canadensis* Mönch clones were compared, in the other nine *P.alba* L. clones and *P ×canadensis* 'Orion' (commercial clone registered for SRC) were tested (fig 3). Species were arranged in plots with 2 replications for each plantation, while poplar clones with 5 replication.

Soils were ploughed (25-30 cm deep) and harrowed before planting. The poplar clones were planted as cuttings (22 cm long) at a density of 6667 cuttings per hectare; black locust, acacia saligna and eucalyptus as 1-year-old seedlings at a density of 3333 trees per hectare.

A semi-automatic transplanting machine was used for all the species and clones. No fertilizer was applied.

During the first year all the fields were irrigated with drip system (table I). Disk-harrowing was carried out two times at Mussomeli and San Cataldo and one time at Misteci only in the first year of cultivation. During the second year any treatment was applied.

Table I: Number of irrigation and quantities of water (mm) received during first growing season per each site.

Site	Number	Quantity (mm)
Mussomeli	15	450
San Cataldo	4	80
Caltanissetta loc. Misteci	2	30

Figure 3: San Cataldo (CL). Clone Orion at the end of 2nd growing season.

To survey the growth of the trees at the end of the first year only tree height was measured. At the end of second growing season, the following variables were recorded on each plot:

- survival of plants.
- number of living shoots with height > 150 cm
- diameters at 130 cm above the ground for all the species
- diameter at 10 cm above the ground only for acacia saligna.
- total height

To assess the above-ground biomass production a sample of 10-30 trees for all species/clones was harvested. To obtain dry weight the samples (stems, branches and leaves) were dried to constant weight in an oven at 103±1°C.

The calorific values of the species utilized in the trials are well-known except acacia saligna. The wood is reported as sappy, light and not popular for firewood [2]. So to verify the fuelwood properties of this species we measured calorific value using a IKA-C200 calorimeter bomb. The sample trees were separated in leaf, branches and stem (whole, wood and bark).

STATISTICA 6.0 for Windows (StatSoft) was used for the analysis of data recorded. Regression equations were used to estimate the biomass productivity expressed in oven dry ton per hectare per year ($Odt \cdot ha^{-1} \cdot y^{-1}$).

Survival data were elaborated previous transformation in arcsen √%.

3 RESULTS AND DISCUSSION

3.1 Dendrometric data

The survival and growth data (table II, III) differ significantly among the species and clone compared. The growth performance of Acacia saligna appeared to be better than for all the other species. Only Eucalyptus can compete.

Table II: Mussomeli (CL). Mean of survival (%), diameter at breast height in mm (D130), total height in cm (Ht), biomass in $Odt \cdot ha^{-1}$ (DB) and in $Odt \cdot ha^{-1} \cdot y^{-1}$ (DBy) of the different species at the end of second year.

Species	%	Sn	D130	Ht	DB	DBy
A. saligna	99	2.5	30	321	24.8	12.4
E. camaldulensis	71	1.7	30	298	10.6	5.3
E. globulus	85	1.1	31	331	7.8	3.9
Black locust	95	1.6	17	227	2.9	1.4
Poplars	57	1.4	22	272	2.9	1.5

Table III: Caltanissetta loc. Misteci. Mean of survival (%), diameter at breast height in mm (D130), total height in cm (Ht), biomass in $Odt \cdot ha^{-1}$ (DB) and in $Odt \cdot ha^{-1} \cdot y^{-1}$ (DBy) of the different species at the end of second year.

Species	%	Sn	D130	Ht	DB	DBy
A. saligna	100	1.0	18	245	4.20	2.10
E. camaldulensis	100	1.0	13	228	3.14	1.57
E. globulus	90	1.1	-	129	0.16	0.08
Black locust	84	1.6	-	68	0.05	0.03
Poplars	85	1.4	-	101	0.08	0.04

Table IV: San Cataldo (CL). Trial with 10 poplar clones (*P. deltoides* and *P ×canadensis*). Mean of survival (%), diameter at breast height in mm (D130), total height in cm (Ht), biomass in $Odt \cdot ha^{-1}$ (DB) and in $Odt \cdot ha^{-1} \cdot y^{-1}$ (DBy).

Species	%	Sn	D130	Ht	DB	DBy
General Mean	61	1.1	15	231	1.09	0.55
Best clone	85	1.0	23	308	2.97	1.50

Table V: San Cataldo (CL). Trial with 10 poplar clones (*P. alba* and *P ×canadensis* 'Orion'). Mean of survival (%), diameter at breast height in mm (D130), total height in cm (Ht), biomass in $Odt \cdot ha^{-1}$ (DB) and in $Odt \cdot ha^{-1} \cdot y^{-1}$ (DBy).

Species	%	Sn	D130	Ht	DB	DBy
P. alba Mean	57	1.1	-	116	0.12	0.06
P.alba Best clone	56	1.3	12	189	0.55	0.27
Orion	94	1.7	18	292	3.81	1.90

Among the poplars (table IV and V) the performance of *P ×canadensis* 'Orion' appeared to be better than for all the other clones tested, but in two year it grow like in one year in northern Italy.

3.2 Above ground biomass production

At Caltanissetta loc. Misteci (table III) the above ground biomass production ranged from 0.05 Odt·ha^{-1} for black locust to 3.14 Odt·ha^{-1} for E. camaldulensis and 4.2 Odt·ha^{-1} for acacia saligna, depending on the adaptability of the different species to dryness.

At Mussomeli, where waste water irrigation was applied, the productivity (table II) was six time higher than Misteci and the performance of Acacia saligna (12.4 Odt·ha^{-1}·y^{-1}), was comparable with the productivity obtained in commercial poplar SRC of the Po valley (North Italy).

The productivity of poplar clones compared in these experiments, including *P. alba* ones considered relatively resistant to dry condition, was very low because poplars need about 700 mm of annual rainfall, 350-400 mm during growing season [3].

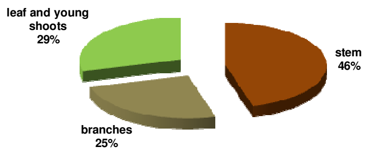

Figure 4: Acacia saligna. Biomass partition on dry basis.

3.3 Calorific value of Acacia saligna

In Figure 4 the partition of Acacia saligna above ground biomass in stem, branches, leaves and young shoot, harvested at the end of the second growing season is reported. Table VI shows the calorific value of the acacia saligna biomass with a moisture content of about 10%. The calorific value of acacia saligna was not different than for the other tree species reported in literature. The lowest value is measured for bark and the highest for the wood. The whole stem has a calorific value lower than leaves and branches, probably because the stem of young trees has a high bark content.

Table VI: Acacia saligna. Calorific value (J·g^{-1}) and moisture content (% on dry basis) of whole tree biomass samples.

	Calorific content		Moisture content	
	Mean	St.dev	Mean	St. dev
Leaves	17307	1169	9.8	0.9
Branches	17281	375	9.7	0.6
Stem:				
Whole	17190	217	9.8	0.1
Wood	17509	182	-	-
Bark	17067	147	-	-

4 CONCLUSIONS

The preliminary results of these trials show a high growth performance of Acacia saligna in marginal soil of Sicily. Only Eucalyptus, particularly *E. camaldulensis*, can compete with it in these sites.

Poplar and Black locust is not adapted to these dry climatic conditions.

Acacia saligna grows on a wide range of soil, it tolerates salt spray, soil salinity and alkalinity and it can produce with less than 500 mm of annual average rainfall. But it is sensible to low winter temperature and it has the potential to become an invasive species. To limit the potential invasiveness of the species these crops should not be cultivated close to natural habitats or ecological corridors [4].

5 REFERENCES

[1] M. Beccali, P. Columba, V. D'Alberti, V. Franzitta, Assessment of bioenergy potential in Sicily: a GIS-base support methodology. Biomass & Bioenergy 33 (2009) p 79-87.

[2] AA.VV. Firewood crops. Shrub and tree species for energy production. National Academy of Science ed. Washington D.C. (1980) p 237. Available on: http://books.google.com/

[3] S. Bergante, G. Facciotto, G. Minotta, Identification of the main site factors and management intensity affecting the establishment of Short-Rotation-Coppices (SRC) in Northern Italy through Stepwise regression analysis, Cent. Eur. J. Biol. 5(4) (2010) 522–530.

[4] R. Crosti, Invasiveness of biofuel crops and potential harm to natural habitats and native species. Final report, CE T-PVS/Inf (2009) p 22.

6 ACKNOWLEDGEMENTS

The trials were carried out in cooperation with Ente regionale di Sviluppo Agricolo (ESA), the Agricultural Regional Agency of Sicily. The Authors are grateful particularly to the technician of the ESA of Caltanissetta province.