

## Some preliminary results from the first vegetative period (2014)

*A large set of data from SustAffor field trials is being gathered. Hereby we present the main trends of tree growth and tree water status during the first vegetative period.*

### Sustaffor project: novel techniques and field trials

The aim of SUSTAFFOR is to conceive, produce, develop and on-field validate novel techniques aiming at improving affo/reforestation projects from an environmental, technical and economic point of view, as well as to explore the synergies between them.

These novel techniques aim at mitigating the negative effect of drought and competitive vegetation, while minimizing the need for maintenance. They include a new generation of soil conditioners and innovative mulching models, either biodegradable or reusable:



Innovative soil conditioner comprising 23 ingredients including a new complex of hydroabsorbent polymers (TerraCottem Internacional)



Recycled rubber based mulch, anti-UV treated, reusable in successive tree plantation projects, 1.5 mm thick (EcoRub)



Woven jute cloth treated with furan bio-based resin for increased lifetime, 100% biodegradable (La Zeloise)



Black new biopolymer-based semi-rigid plate, 100% biodegradable (DTC)



Black new biopolymer-based frame, 100% biodegradable, fused to a commercially available black biodegradable film (DTC)

This **fourth newsletter** presents preliminary results corresponding to the first vegetative period (2014), obtained from the network of field trials installed in four contrasted bioclimatic areas in NE Spain: Semiarid, Mediterranean Continental, Mediterranean Humid and Montane. The [Newsletter 2](#) provided a whole description of the network of field trials and the experimental design, while [Newsletter 3](#) described the monitoring performed.

### Please notice...

We are currently analyzing data from further tree and soil variables from both the first and second vegetative period, so the information presented in this Newsletter should be considered as preliminary. The overall project results and conclusions will be presented in the last Newsletter, foreseen at the end of 2015.

Moreover, it should be considered that 2014 was an abnormally wet year, which may have somehow masked the results presented herein.

## Field trials, treatments and variables considered

In order to present a comprehensive summary with the preliminary trends, this Newsletter focuses on one field trial per bioclimate (Field trials 1, 3, 5 & 7 – described in Table 1), for the techniques and treatments provided in Tables 2 & 3.

Table 1. Main features of the field trials whose preliminary results from 2014 are depicted in this Newsletter. Their whole description is provided in [Newsletter 2](#)

Bioclimate	Semiarid	Med Continental	Med Humid	Montane
Field trial number - location	1 - Mequinenza	3 - Solsona	5 - Banyoles	7 - Fontanals
Altitude (m)	210	672	215	1,430
Site type	Forest area burnt in 2005	Abandoned arable field	Abandoned arable field	Abandoned grazing area
Aspect, slope	South, 40%	Flat	Flat	North, 30%
Mean annual temperature (°C)	15.0	12.0	14.0	7.5
Annual / summer precipitation (mm)	371 / 69	683 / 165	872 / 213	887 / 272
Climate type (Köppen)	BS: Steppe climate, cold	Csb: temperate, dry mild summer	Cfb: Maritime temperate	Cfc Temperate/ Dfb Continental
Soil texture	Loamy-sandy	Loamy-clayish	Loamy-silty	Loamy-sandy
Tree species	Aleppo pine ( <i>Pinus halepensis</i> )	Hybrid walnut ( <i>Juglans x intermedia</i> )	Hybrid walnut ( <i>Juglans x intermedia</i> )	Mountain ash ( <i>Fraxinus excelsior</i> )

Table 2. Techniques analyzed in this Newsletter

Technique	Description	Code
Soil conditioners	Innovative soil conditioner (TerraCottem Internacional) Utilized at 3 doses: 20, 40 and 80 g/tree	ISC20 ISC40 ISC80
	Commercially available soil conditioner TerraCottem Universal®. Dose: 40 g/tree	CommSC40
	No application of soil conditioner	NoSC
Weeding techniques	Black new biopolymer-based frame mulch (DTC)	BIOFRA
	Woven jute cloth (La Zeloise)	JUTE
	Recycled rubber based mulch (EcoRub)	RUBBER
	Commercial black polyethylene film, anti-UV treated, 80 µ	CommPE
	Commercial green biodegradable woven biofilm	CommBF
	Herbicide application (glyphosate, 14.4 cm <sup>3</sup> /tree at 1.25%)*	CommHER
	No application of weeding	NoWeeding

\* except in Semiarid & Montane conditions, due to low weed competitiveness.

Table 3. Treatments (combinations of soil conditioning and weeding techniques) analyzed in this Newsletter; the studied treatments are indicated by an X.

Soil conditioner Weeding technique	ISC20	ISC40	ISC80	CommSC40	NoSC
BIOFRA		X			X
JUTE		X			X
RUBBER		X			X
CommPE	X	X	X	X	X
CommBF		X			X
CommHER		X			X
NoWeeding		X			X

The variables considered for the preparation of this Newsletter are:

- A. Tree survival and growth
- B. Tree water status

### A. Tree survival & growth

The survival rates in all field trials have been very high in general (Table 4).

Table 4. Survival rates in the four field trials analysed

Bioclimate	Field trial number (species)	Tree survival (%)
Semiarid	1 ( <i>Pinus halepensis</i> )	93
Med Continental	3 ( <i>Juglans x intermedia</i> )	99
Med Humid	5 ( <i>Juglans x intermedia</i> )	100
Montane	7 ( <i>Fraxinus excelsior</i> )	99

Tree growth was affected by the different treatments in all field trials, as shown in Figure 1:

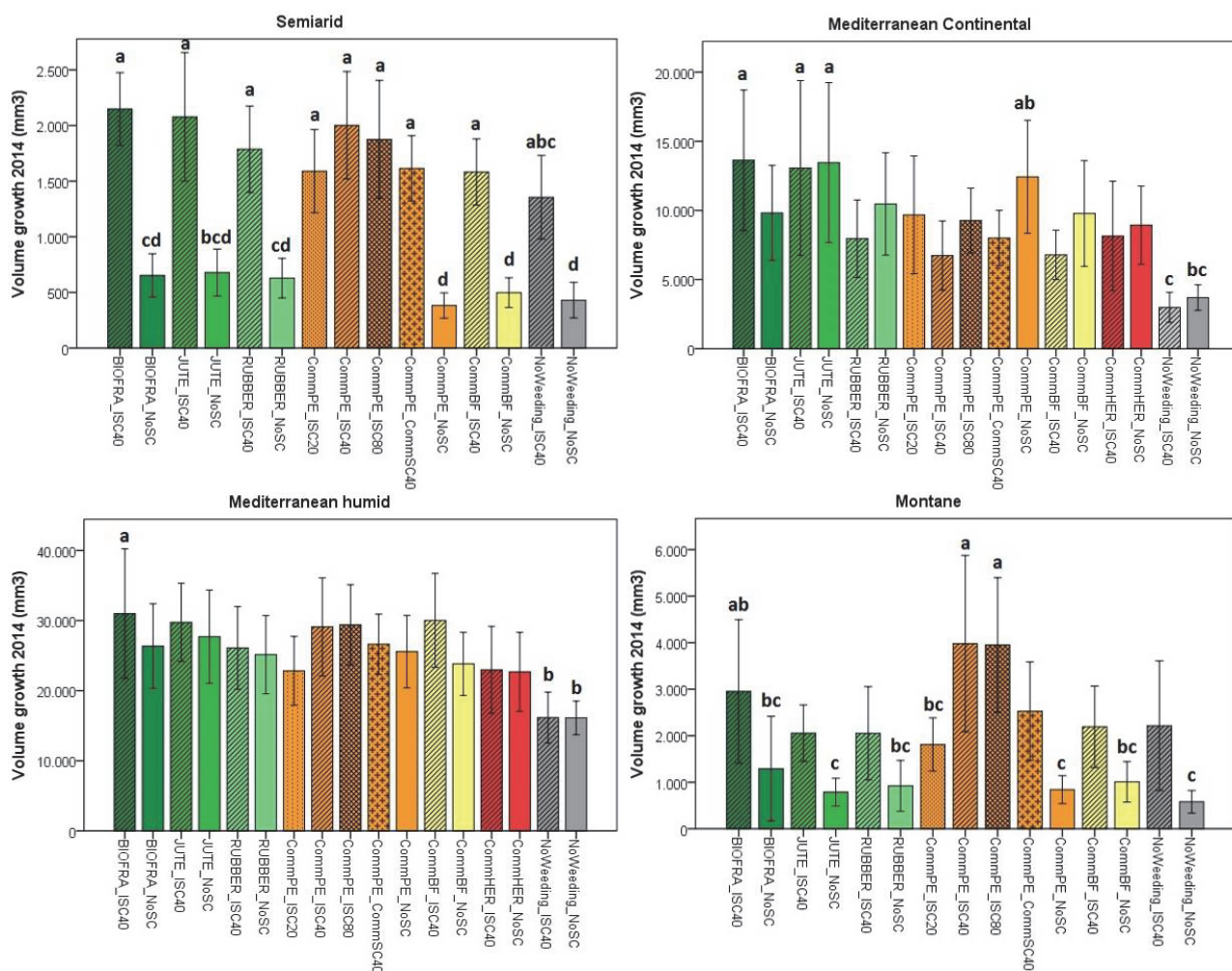


Figure 1. Seedling growth (mm<sup>3</sup>) during the first vegetative period, for all treatments. The different letters correspond to grouping based on Tukey test ( $p > 0.05$ ), for those treatments leading to results significantly different to others. Source: Coello et al. 2015

The conclusions of the analysis of the individual effect of the soil conditioning techniques and of the weeding techniques on tree growth are the following:

**Semi-arid:** soil conditioning had a positive effect increasing tree growth (both formulations increased tree growth significantly compared to No soil conditioning). Weeding also favoured tree growth: polyethylene, bio-based framed and jute mulches resulted in significantly higher tree growth than No weeding.

**Med Humid:** soil conditioning did not increase significantly tree growth, while all weeding techniques except for herbicide had a positive effect compared to No weeding. No significant difference was found between the different weeding techniques.

**Montane:** soil conditioner applied in doses of 40 g (both formulations) or 80 g (innovative formulation) had a significantly positive effect on tree growth, compared to No soil conditioning. However, weeding did not have a major effect, and only polyethylene mulching provided higher tree growth rates than No weeding.



## B. Tree water status

Figure 2 summarizes the preliminary results of tree water status for the different weeding treatments.

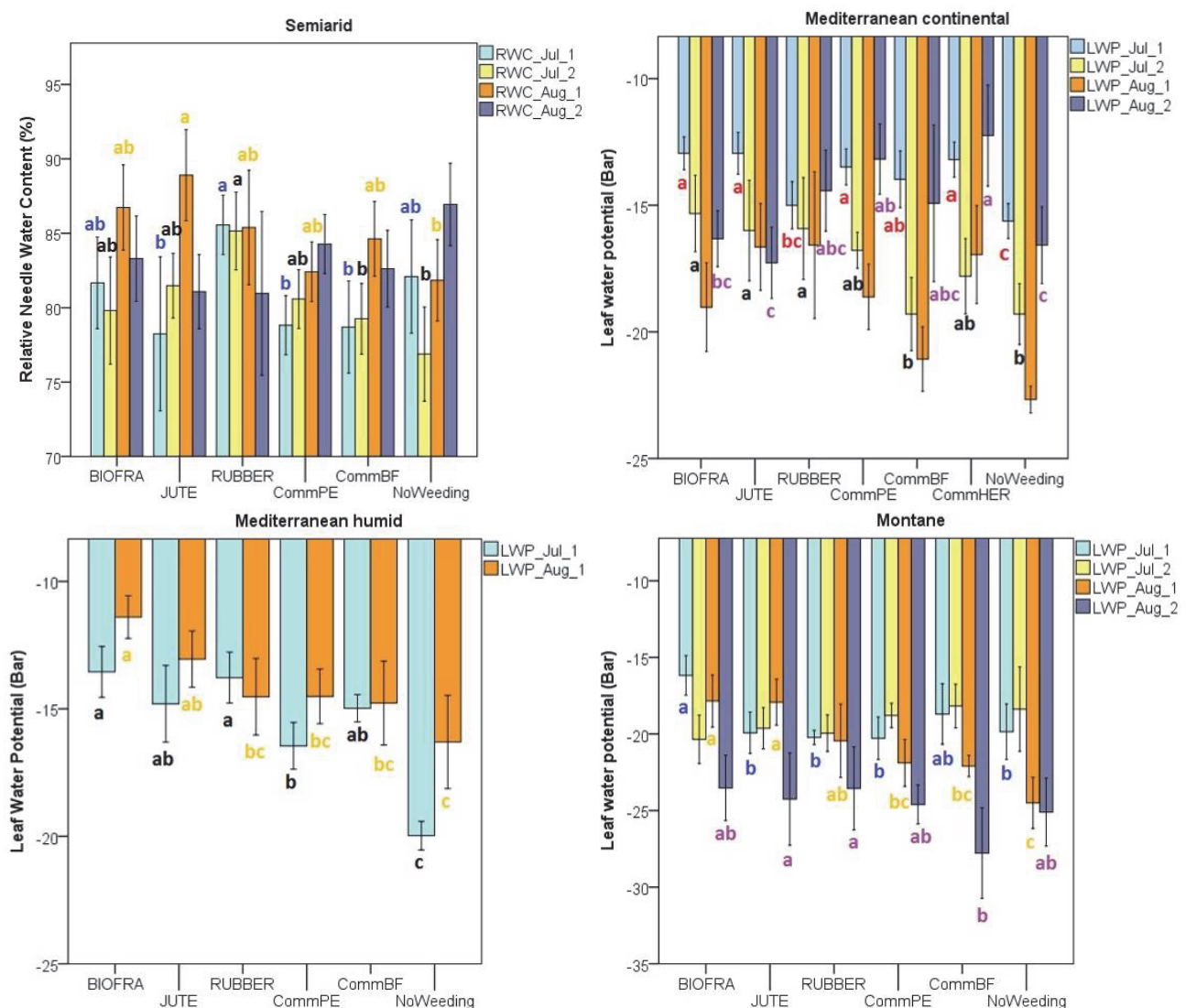


Figure 1. Weeding treatments and tree water status. The different letters are the grouping based on Tukey test ( $p > 0.05$ ), for treatments significantly different to others. Coello et al. 2015

The main trends of the effect of the different treatments on tree water status are:

**Semi-arid:** rubber mulch provided the overall best tree water status, together with jute mulch. Commercial biofilm mulch and No Weeding led to the poorest tree water status.

**Med Continental:** polyethylene mulch and herbicide led to the best tree water status, while No weeding resulted in the worst ones.

**Med Humid:** bio-based framed mulch led to the best tree water status, while the worst results were provided by polyethylene mulch and especially by No weeding.

**Montane:** bio-based framed, jute and rubber mulches resulted in better tree water status than No weeding and, less evidently, than polyethylene and commercial biofilm.

## PRELIMINARY CONCLUSIONS OF THE FIRST VEGETATIVE PERIOD

→ Soil conditioners and weeding showed a positive effect on tree growth and tree water status already during the first year of plantation. The effect of the different treatments depended largely on the particular site conditions:

- In conditions limited by low water input (Semiarid) and/or by thick textured soil with poor water holding capacity (Semiarid and Montane), soil conditioning significantly enhances tree growth. In these conditions, the effect of mulching on the mitigation of soil water evaporation can also increase tree growth and water status.

- In rich sites, well supplied with water and where weed competition is a major menace for reforestation (Med Continental and Med Humid), weeding results in significant growth and water status gains since the first year, while soil conditioning does not lead to significant effects.

→ The innovative soil conditioner proved to be at least as effective as the commercially available version, seeming a very promising alternative.

→ The innovative weeding techniques led in general to outcomes similar to polyethylene mulching and herbicide application, and often superior (in terms of tree water status) to the commercially available biofilm. Among them, Jute mulch tended to provide best results in Med continental and Montane conditions, Rubber mulch was especially effective in Semiarid and Montane sites and the New biopolymer-based framed mulch performed especially well in Med humid and Montane conditions.

These results are preliminary and refer only to the first vegetative period. They must be therefore complemented by those from further vegetative periods and variables, in order to adequately assess the effects of the different techniques in the midterm, as well as their durability and service life.

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### References

Coello-Gomez, J., Fuentes-Boix, C., Piqué, M. Innovative soil conditioning and mulching techniques for forest restoration in Mediterranean conditions. IUFRO Reforestation Challenges. Belgrade (Serbia), 3-6 June 2015