

SUSTAFFOR PROJECT

Innovation in forest restoration

Bridging effectiveness and sustainability in afforestation /reforestation in a climate change context: new technologies for improving soil features and plant performance

FP7-SME-2013-606554



What is Sustaffor? - Sustainable Tree Planting

Every year millions of Euros are invested on the maintenance (especially weeding and watering) of newly planted trees in landscaping, afforestation, reforestation, gardening, fruit production... This maintenance frequently implies a massive use of herbicides, petrol-based fuels and labour. These trees are often dependent on these tending operations, which are not always foreseeable or implementable by public or private managers, which lead to the partial or total failure of many trees planting projects.

In order to provide new answers to these situations, a consortium of 10 European entities (**6 Small or Medium size Enterprises – SMEs and 4 Research & Development performers – RTDs**) launched **Sustaffor project**.

SUSTAFFOR has as main objective to develop and validate novel techniques aiming at improving tree planting projects from an environmental, technical and economic point of view, and to explore the synergies between them. These **novel techniques aim at mitigating the negative effect of temporary water scarcity and competitive vegetation**, which are the two main factors that can result in the failure of a young tree in the current context of irregular water availability and climate change.



Plantation on former agricultural field



Afforestation in a degraded area

Sustaffor novel techniques

INNOVATIVE SOIL CONDITIONER

Soil conditioners are products mixed with the soil aiming at retaining and releasing water available for plants while improving soil structure and fertility. During the project a novel mix of a new high-performance hydro-absorbent polymer combined with fertilizer and growth precursors is developed by **TerraCottem Internacional**. This company is developer and distributor of the TerraCottem® soil conditioning technology, a proprietary mixture of polymers, fertilizers, growth precursors and carrier material that is unique for its synergetic effect.

INNOVATIVE GROUNDCOVERS

Groundcovers or "mulches" are physical barriers aiming at impeding the establishment of competitive vegetation (thus avoiding the need for weeding) and reducing soil water evaporation in the area of soil occupied by the tree roots. During the project 4 novel groundcovers are developed:

- **A 100% biodegradable frame, based on a new biopolymer formulation**, developed by **DTC**, fused to a commercially available biodegradable film. This company is expert in the fabrication of specialized plastic and bio-plastic products by mould injection.
- **A 100% biodegradable semi-rigid mulch based on a new biopolymer formulation**, developed by **DTC**.
- **A 100% biodegradable mulch made with woven jute cloth treated with furan bio-based resin for increased durability**, developed by **La Zeloise NV**. This company works with natural fibre products, especially recycled jute, treated with innovative finishing techniques for enhanced properties.
- **A long-lasting mulching mat based on recycled rubber**, reusable in successive tree plantation projects, developed by **EcoRub bvba**. This company is experienced in the production of agro-forestry auxiliary products based on recycled rubber, coming from worn-out tyres and conveyor belts.



Soil conditioner
(TerraCottem
Internacional)



Bioplastic framed
mulch (DTC)



Bioplastic semi-rigid
mulch (DTC)



Woven jute mulch
(La Zeloise)

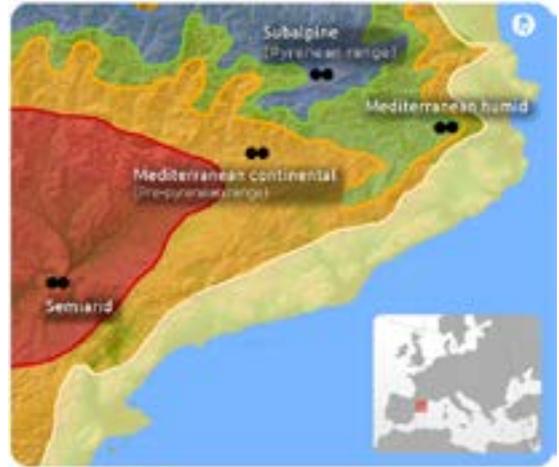


Reusable rubber
mulch (EcoRub)

Sustaffor field trials network

For studying the potential of the novel techniques in tree planting projects a network of 8 field trials was installed in March 2014 across a range of 4 strongly contrasted climatic areas in NE Spain, representative of the main climates in Europe and the Mediterranean. The species chosen are the most commonly utilized in each area:

- **Semi-arid:** Aleppo pine (*Pinus halepensis*) in north-facing and south-facing slopes
- **Mediterranean continental:** hybrid walnut (*Juglans x intermedia*) Mj209xRa and holm oak (*Quercus ilex*) mycorrhized with black truffle (*Tuber melanosporum*)
- **Mediterranean humid:** hybrid walnut (*Juglans x intermedia*) Mj209xRa and stone pine (*Pinus pinea*)
- **Subalpine:** mountain ash (*Fraxinus excelsior*) and birch (*Betula pendula*)



Semi-arid



Mediterranean continental



Mediterranean humid



Subalpine

Sustaffor experimental design and monitoring

Each field trial includes 17 treatments, with 30 trees per treatment organized in a split-plot design: 6 blocks of 5 trees. The treatments are combinations of soil conditioners and weeding techniques, indicated with an  at the following table.

Weeding technique	Soil conditioner				
	TerraCottem Universal+ 20g/tree	TerraCottem Universal+ 40g/tree	TerraCottem Universal+ 80g/tree	TerraCottem Universal Standard 40g/tree	Control (no conditioner)
Bioplastic framed mulch (DTC)					
Bioplastic semi-rigid mulch (DTC)					
Jute mulch (La Zeloise)					
Rubber mulch (EcoRub)					
Polyethylene mulch					
Current bio-mulch					
Herbicide application					
Control (no weeding)					

Techniques marked in green are novel techniques while those in blue are reference techniques

 Only in Subalpine conditions

Field trials monitoring

In order to achieve project aims a thorough monitoring is applied at the field trials. Collected data refers to weather (through weather stations), tree survival, growth and biomass allocation; tree physiology (leaf water status, nutrition status) soil moisture and temperature; fertility-related soil variables (texture, organic matter, total N, carbonates, pH, etc) and variables related to biochemical changes in soil organic matter:



Measurement of leaf water potential with pressure chamber



Measurement of soil moisture with TDR + access tube



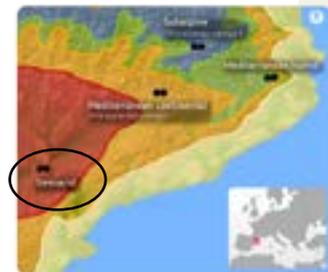
Weather station

Results in Semiarid conditions

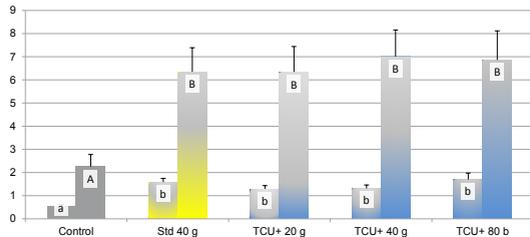
- Poor, light soil - Severe drought

Very positive effect of soil conditioner:

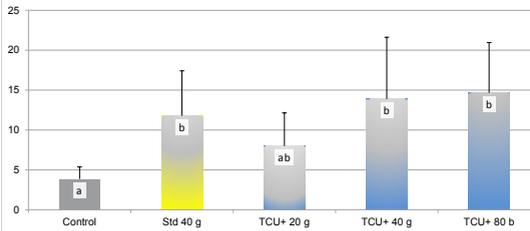
- Tree growth (above and belowground)
- Tree water status



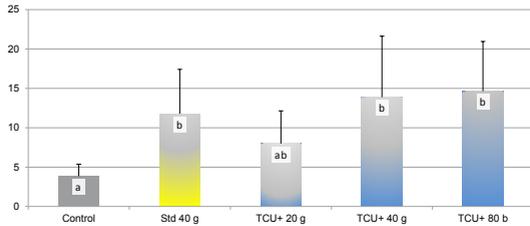
N-facing Semiarid conditions - Volume growth (cm³) 2014-2015



S-facing Semiarid conditions - Aleppo pine biomass (g) 1st vegetative period



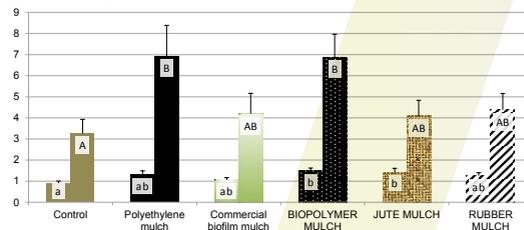
S-facing Semiarid conditions - Aleppo pine biomass (g) 1st vegetative period



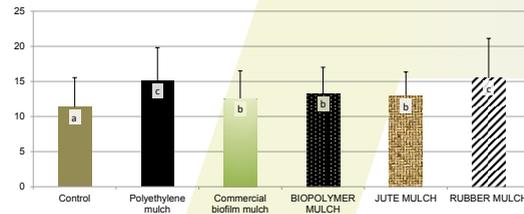
Slightly positive effect of mulching:

- Tree growth (above and belowground)
- Soil moisture

S-facing semiarid conditions - Aleppo pine volume growth (cm³) 2014-2015



N-facing Semiarid conditions - Soil moisture at depth 20-40 cm (%) 2014-2015



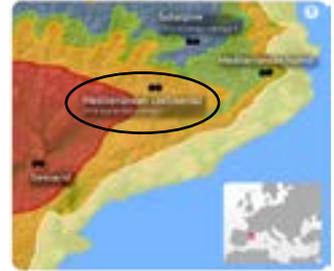
Results in Mediterranean continental conditions

- Rich, loamy soil - Slight drought

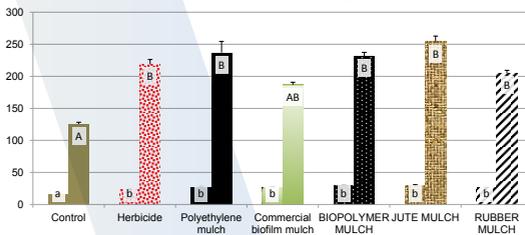
No major effect of soil conditioner

Positive effect of weeding and mulching:

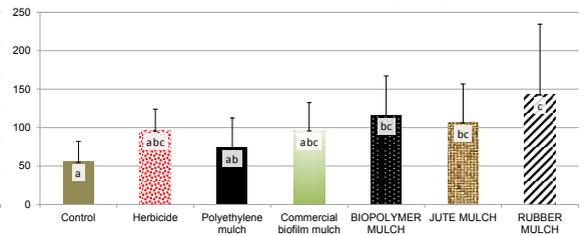
- Tree growth (above and belowground)



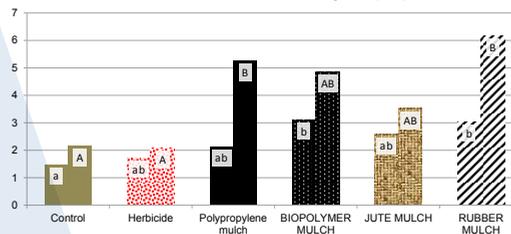
Med continental conditions - Hybrid walnut volume growth (cm³) 2014-2015



Med continental conditions - Hybrid walnut root biomass (g) 1st vegetative period



Med continental conditions - Holm oak volume growth (cm³) 2014-2015



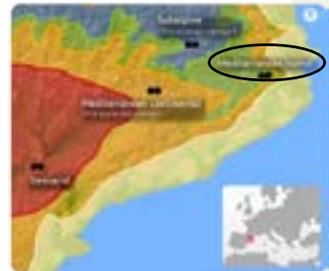
Results in Mediterranean humid conditions

- Rich, loamy soil - No drought

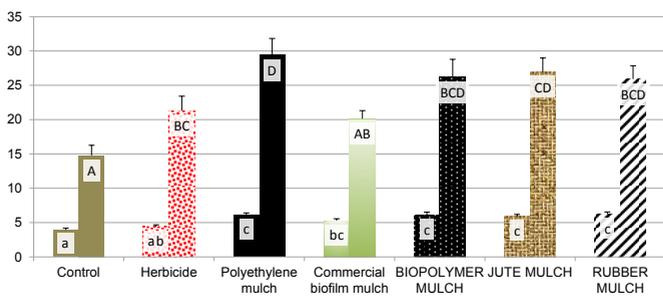
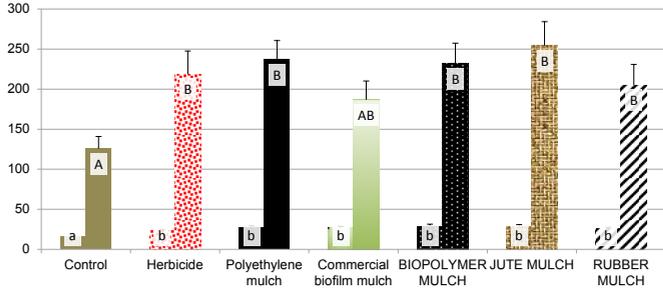
No remarkable effect of soil conditioner

Positive effect of weeding and mulching:

- Tree growth (above and belowground)



Med humid conditions - Hybrid walnut volume growth (cm³) 2014-2015



Results in Montane conditions

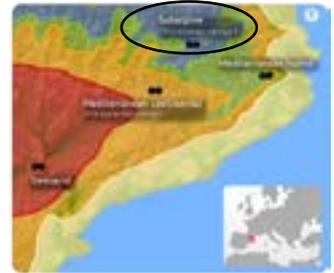
- Poor, light soil - Low temperatures

Positive effect of soil conditioner

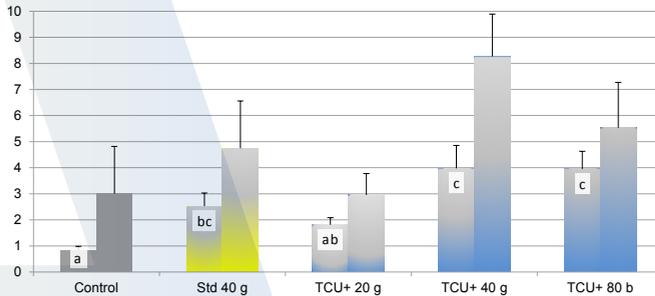
- Tree growth

Positive effect of weeding and mulching:

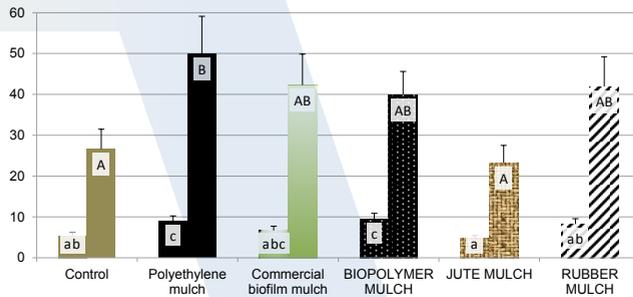
- Tree growth



Montane conditions - Ash volume growth (cm³) 2014-2015



Montane conditions - Birch volume growth (cm³) 2014-2015



Conclusions

New soil conditioner:

- Excellent performance in areas with poor, light soil, especially when subject to severe drought
- New formulation: at least as effective as the commercial version; 40 g/tree was the optimal dosage
- Very easy to install, not requiring maintenance

New mulches:

- Excellent performance in productive sites
- New models: at least as effective as herbicide weeding and commercial mulches (polyethylene & biofilm)
- New biopolymer mulch & jute mulch: 100% biodegradable, especially interesting for tree planting / forest restoration in sites where the investment in maintenance is intended to be minimized (poorly accessible, minimal management schemes).
- Recycled rubber mulch: extremely durable, especially interesting for urban & landscape tree planting



Sustaffor consortium

4 SMEs producing novel techniques:



TERRACOTTEM

2 SMEs commercializing novel techniques:



4 Research & Technology Developers:



edma



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Project Coordinator: Forest Sciences Centre of Catalonia – CTFC

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www.sustaffor.eu