Thematic axis workshops

- thematic partner Axis **T2** **Natural risks management, especially wildfires -**

Name of the Project: **CypFire** **(2G-MED09-070, 2010-2013)**

Name of the Partner: **IPP-CNR (Florence, Italy)**

Name of the speaker: **Gianni Della Rocca**

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Current fire management privileges fire suppression and tends to ignore land management issues

Classification of fuel in relation to its expected flammability is an essential component of fire hazard assessment.

Flammability is like a state of 'quality' of fuel…

- Organ level (widely studied and experimentally assessed in the laboratory)
- Plant level X only empirical observations
- Stand level X only empirical observations

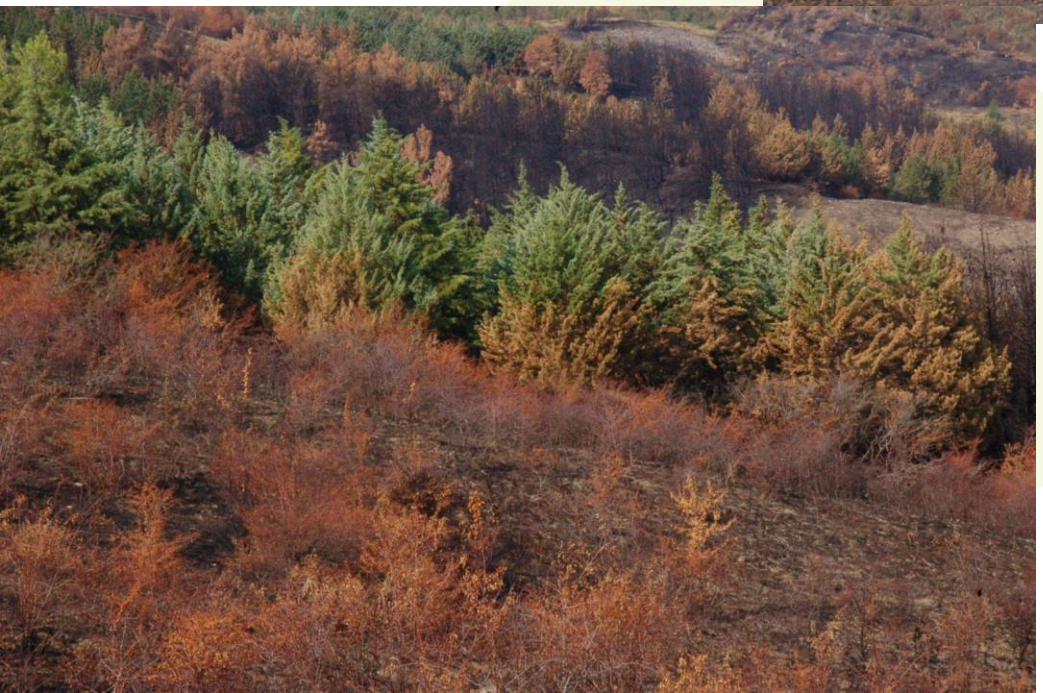
Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

How was born the Idea ?

- traditional fire-break strips reinforced with cypresses (Tuscany, Turkey)

to maintain free from vegetation with recurrent cuttings is rather expensive….

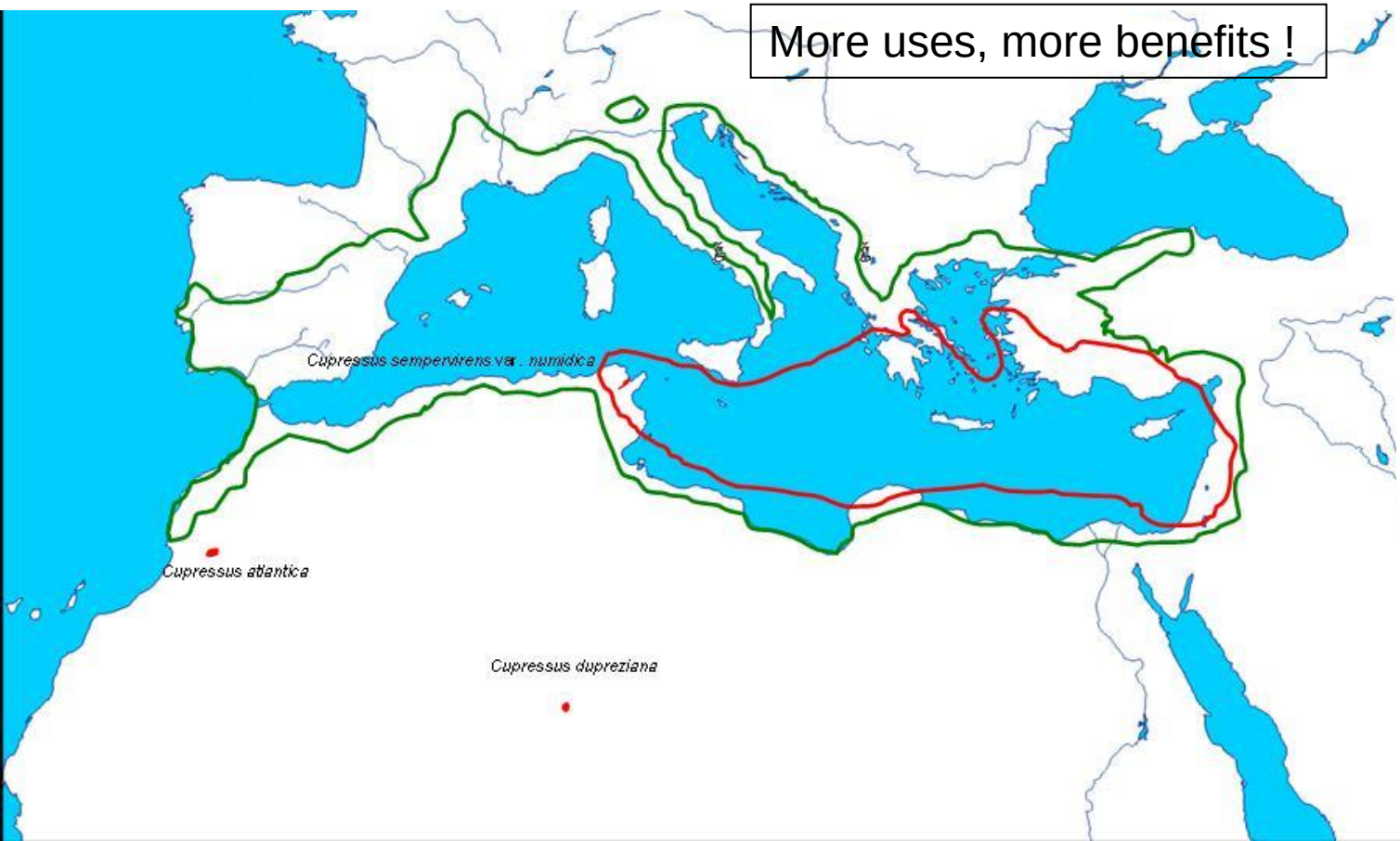
could the cypress be useful as natural
'green' fire-break ????



Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Why to use the Cypress ?

Cypress is considered as a strategic multipurpose native tree and it is increasingly used to control and mitigate the major current environmental constraints as desertification, soil erosion /protection, environmental restoration (case of quarry)



C. sempervirens is a ubiquitous species (ecological plasticity), spread almost everywhere in the meso- and xero-Mediterranean zones.

ar le Fonds Européen
t Régional (FEDER)
d by the European Regional
d (ERDF)

Two morphological varieties characterized by a different habit can be distinguished:

With regards to fire

C. sempervirens var. *sempervirens*, or var. ***horizon*talis** that has a sparser crown and no dead foliage remains trapped in it

C. sempervirens var. ***pyramidalis***, or var. *fastigiata* or var. *stricta* that has a very dense crown which favours the accumulation of dead vegetal material inside.

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

"The Role of Cypress in controlling Forest Fires"

From laboratory experiment to 'fire break' barrier

The use of selected cultivars resistant to bark canker (the most dangerous disease of cypress worldwide caused by the fungus *Seiridium cardinale*) ensures integrity of plantations avoiding the presence of dead crowns parts and of resinous fuel on diseased trees.

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Stressed plants, whatever the cause, have a lower water content, and this increases their flammability.

Cypress stands attacked by bark canker have considerable amounts of dead crowns and also resin emissions on twigs, branches and trunks and hence are more flammable.

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

On the frame of CypFire, in collaboration with the INIA of Madrid and the IMELSA of Valencia we established a complete and standardized protocol to characterized the flammability of *C. s.*var. *horizontalis* at organ level, through the evaluation of the main descriptors of the flammability, using different bench-scale techniques.

Common name	Standard guideline	Title of test	Adaptation to forest fuels	Flammability component evaluated
Oxygen bomb	ISO 1716	Determination of the heat of combustion/gross calorific value	(several authors)	Sustainability
Mass Loss Calorimeter	ISO 13927	Heat release test using a conical radiant heater	(Madrigal et al. 2009; 2013)	Ignitability Sustainability Combustibility Consumability
Epiradiator	ISO 5657	Ignitability of building products using a radiant heater source	(Valette 1990)	Ignitability

Both **litter** (dead fuel) and **biomass** (live fine twigs) were considered. Both fresh and dried

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Mass Loss Calorimeter

Epiradiometer

- Crown strata (top, center, base)
- Heat flux (two levels simulating moderate and severe fire)

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

ORGAN LEVEL

Main Laboratory Results

Flammability could be explained by:

- **physical structure** (shape, size, surface/volume ratio)
- **chemical composition** (ash content and composition, lignin/cellulose ratio, VOC content)
- **physiological traits** of the fuel (moisture content)

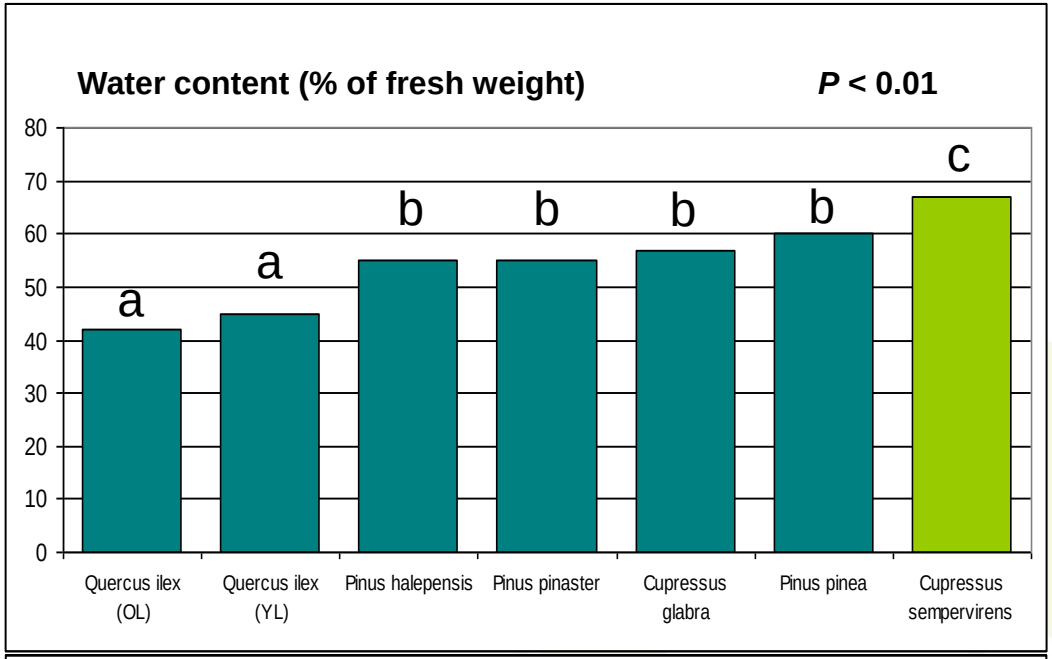
Fuel Moisure Content

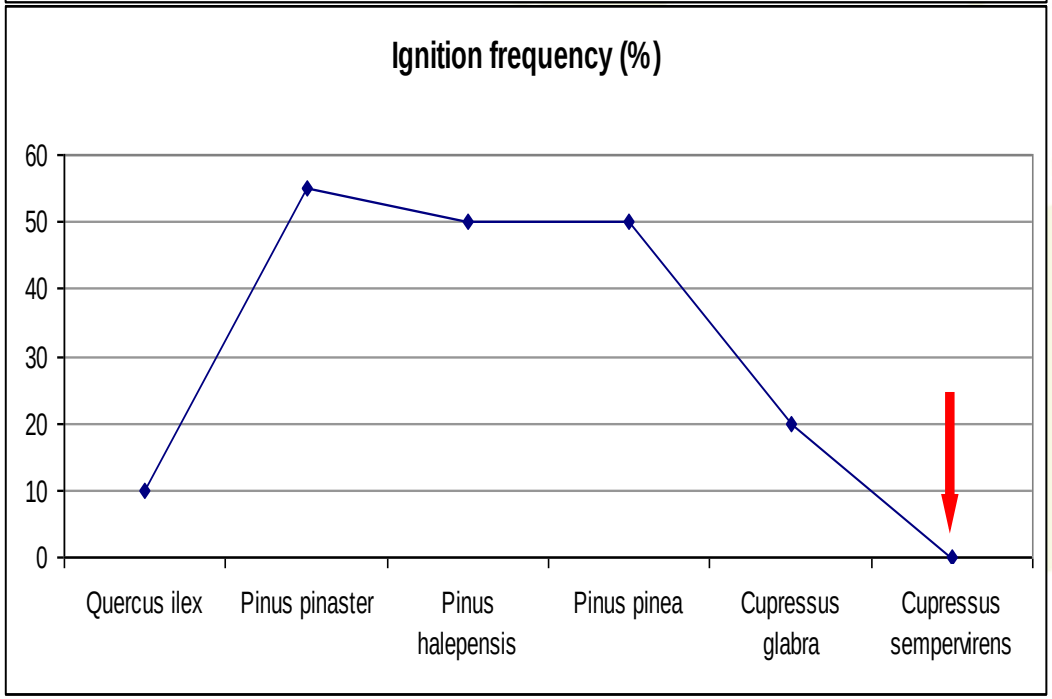
Fine live *C. sempervirens* **moisture content was relevant** (108%-85%) and **rather constant** during the warm and dry season (from April to the middle of August).

The moisture have a major importance in explaining ignitability

Several authors showed that FMC of fine live Mediterranean forest fuels may be as low as 50-60% during the summer season much lower than in *C. sempervirens* samples….

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)





ORGAN LEVEL

Moisture analyzer - Biomass

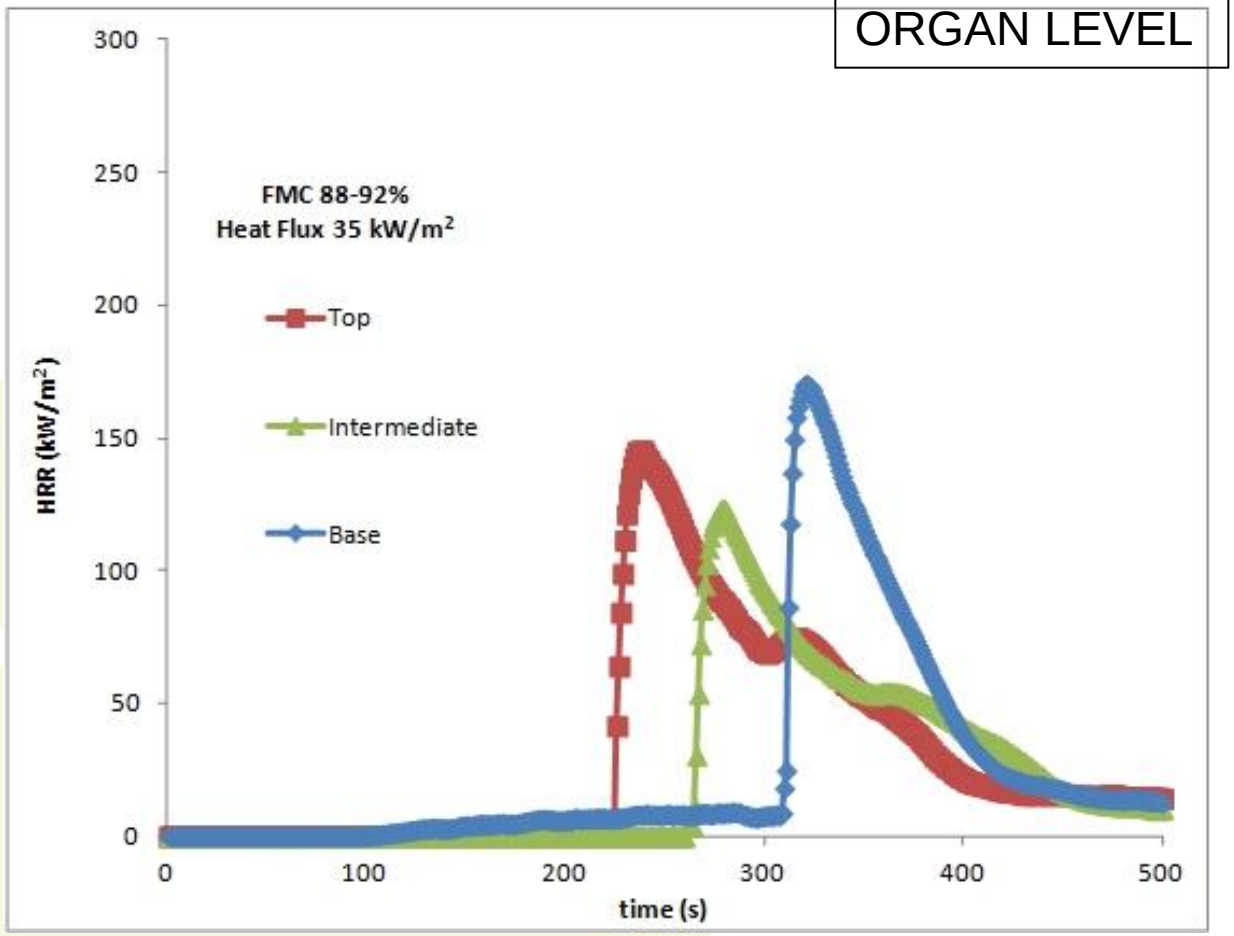
At lower temperature (250°C) the IF of fresh live fine fuel was only 0-23% while over 400°C all samples burned

Epiradiator test - Biomass

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

ORGAN LEVEL

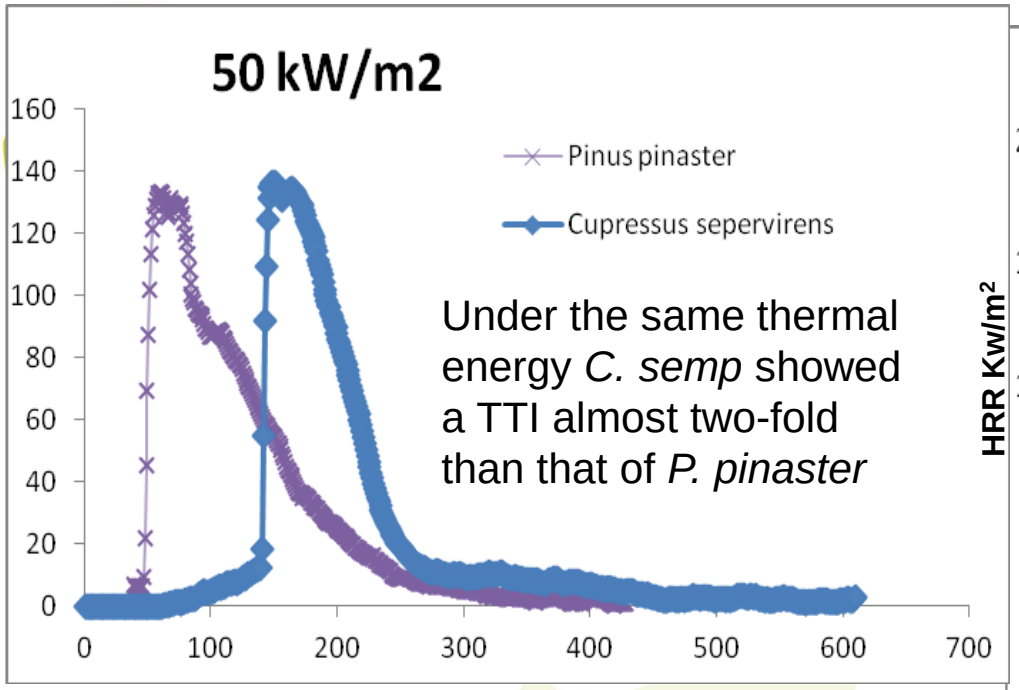
Biomass – MLC results



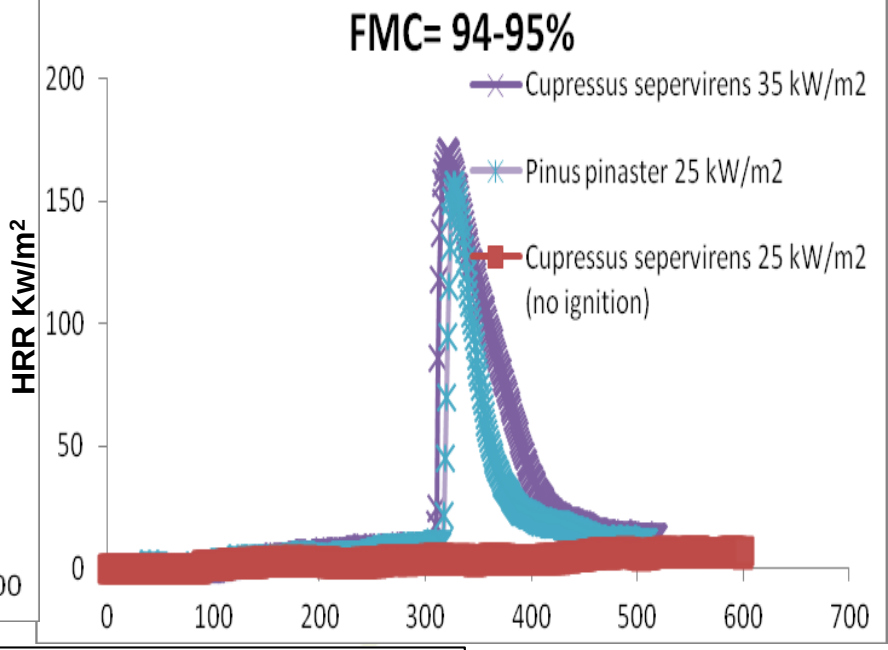
Higher TTI in the lower part of the crown

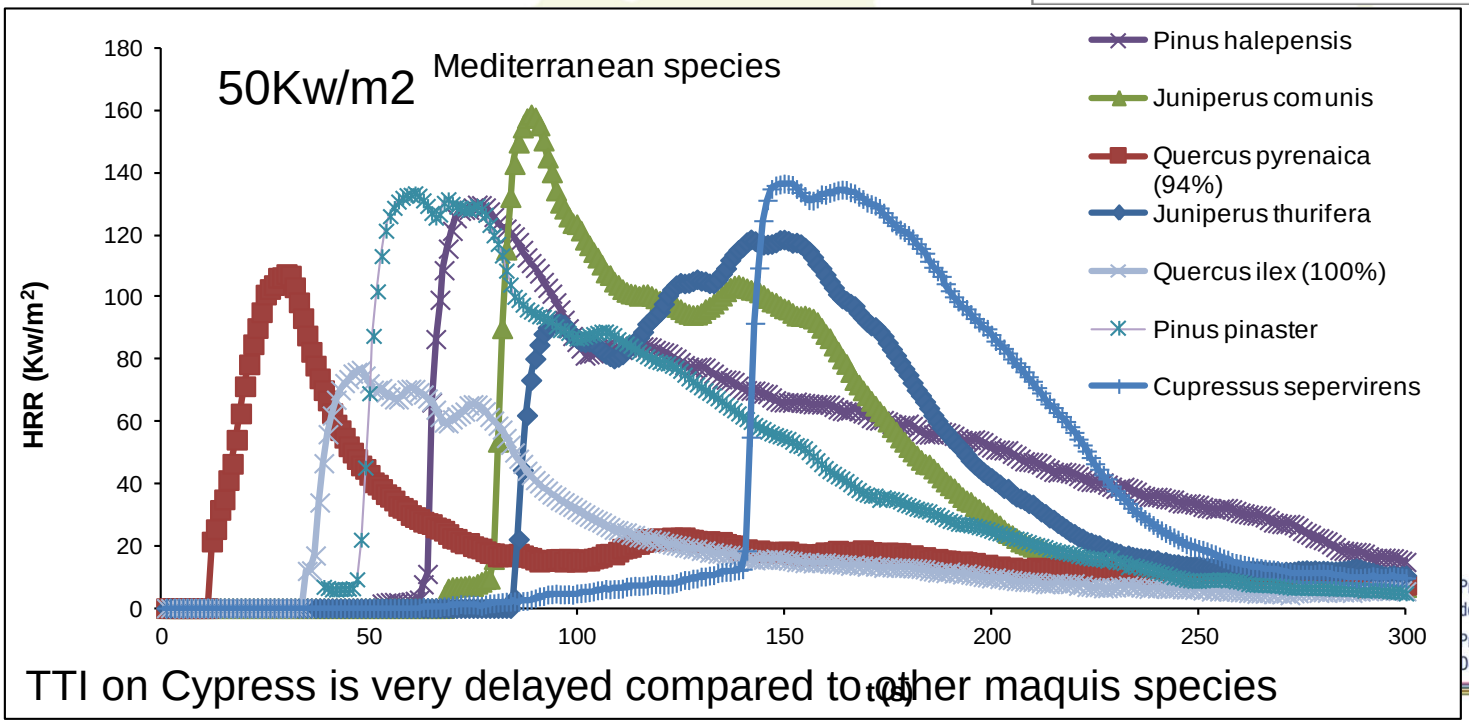
Time to ignition: time that elapses between the deposition of the sample on the heating source and the appearance of the flame;

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)



Under the same thermal energy *C. semp* showed a TTI almost two-fold than that of *P. pinaster*





TTI on Cypress is very delayed compared to other maquis species

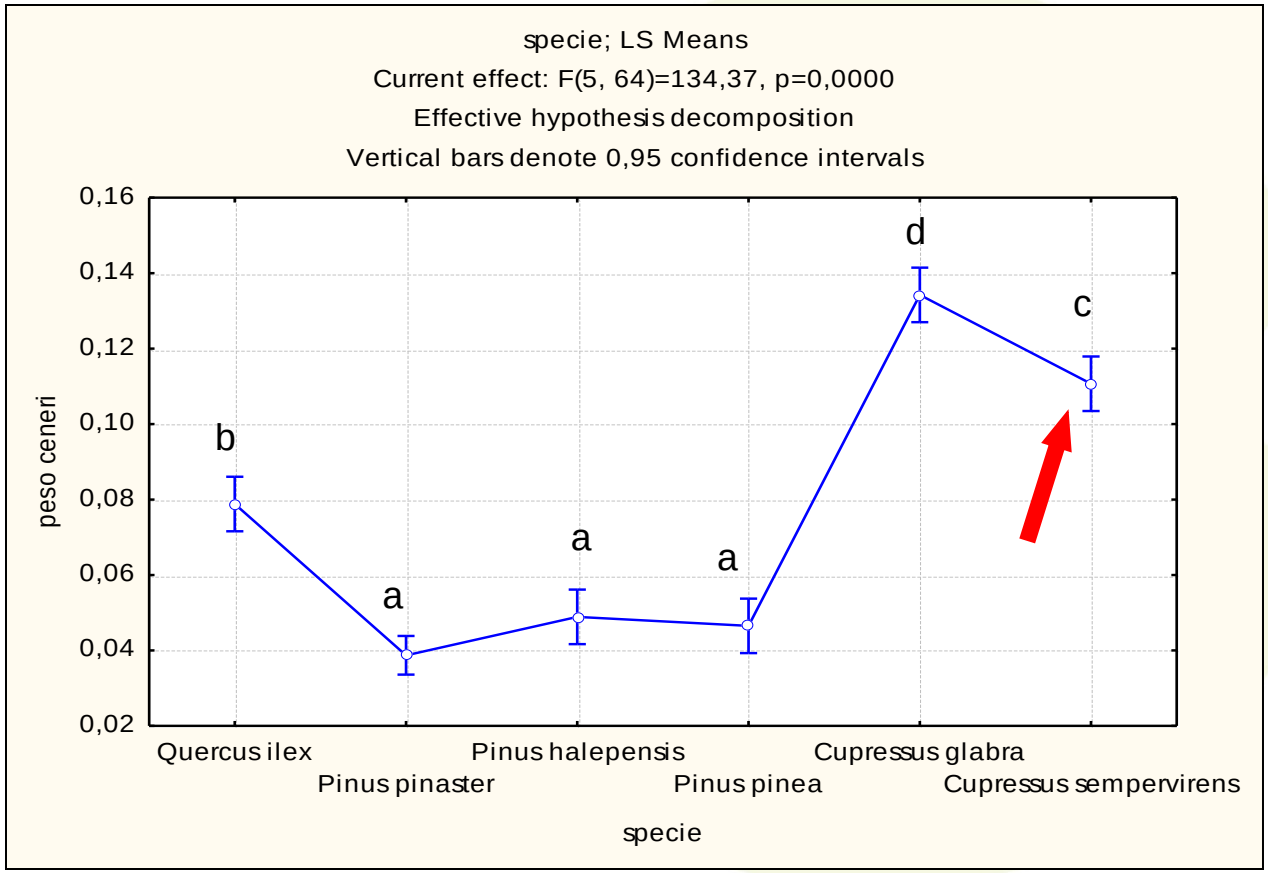
The energy released by *C. sempervirens* at 35 kW was similarly emitted by *P. pinaster* but when exposed to 25 kW only (at 25 kW C. semp. is not burning)

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)
MED CAP

ORGAN LEVEL

Ash content

Biomass (gr on 1 gr samples)



High percentage of ash content basically means less mass to burn

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

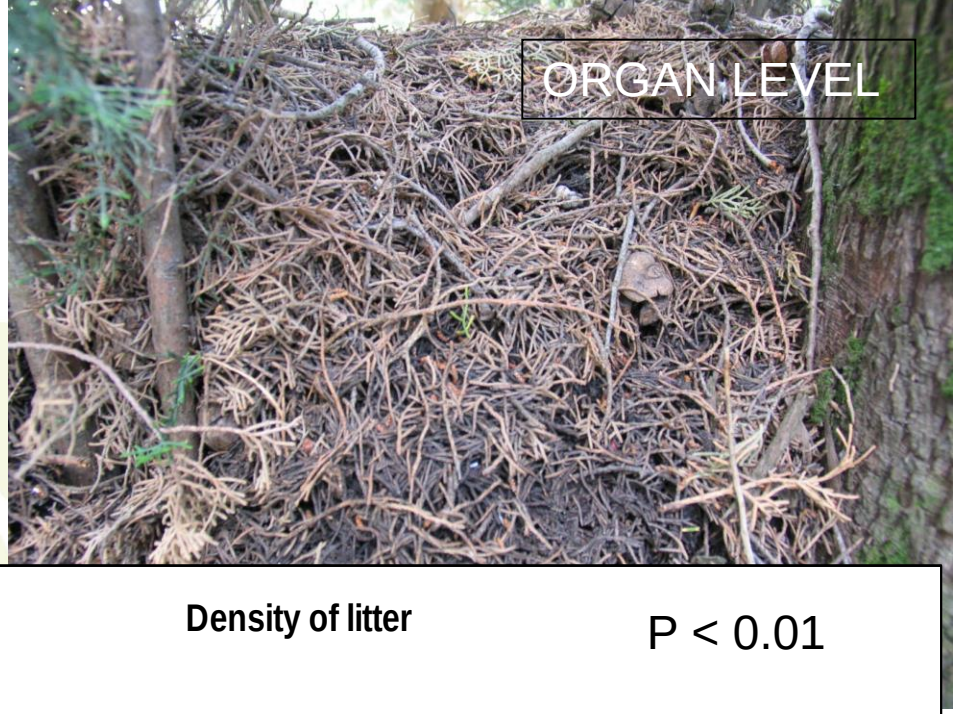
Role of VOC

Ignition of cypress fresh biomass did never take place by gases inflammation ! (on the contrary to the pines)

VOCs are stored in cypress in leaf glands but they seems to be degassed at low temperature 60-150°C during the warming up of vegetation and they do not contribute to ignition.

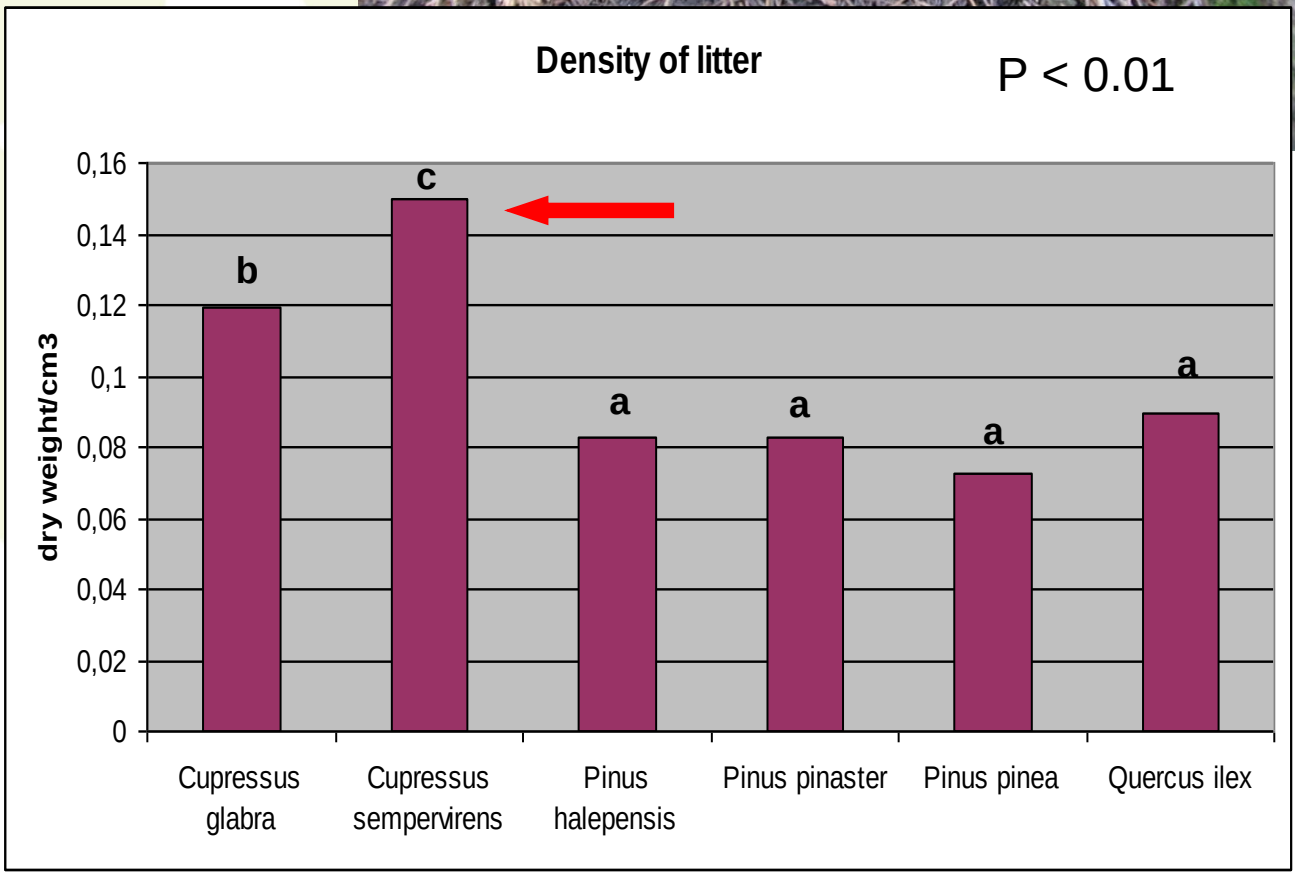
Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Structural arrangement of fuel influence flammability



Cypress litter

- slow decomposition = high accumulation;
- is composed by short and thin segments densely wedged each other;
- reduced circulation of air and remarkable capacity to retain humidity;



PLANT LEVEL

Architecture of the crown and habitus

Common cypresses (var. horizontalis) has a rather **thick crown** compared to other conifers (e.g. pines).

Physical structure and components (e.g. branch size, leaf size and shape and retention of dead material) are the main characteristics affecting species flammability.

- act a physical barrier
- reduced circulation of air within the crown;
- maintenance of humidity inside

(all factors reduce flammability).

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Development of understory vegetation

Absence of understory in cypress stands
due to:

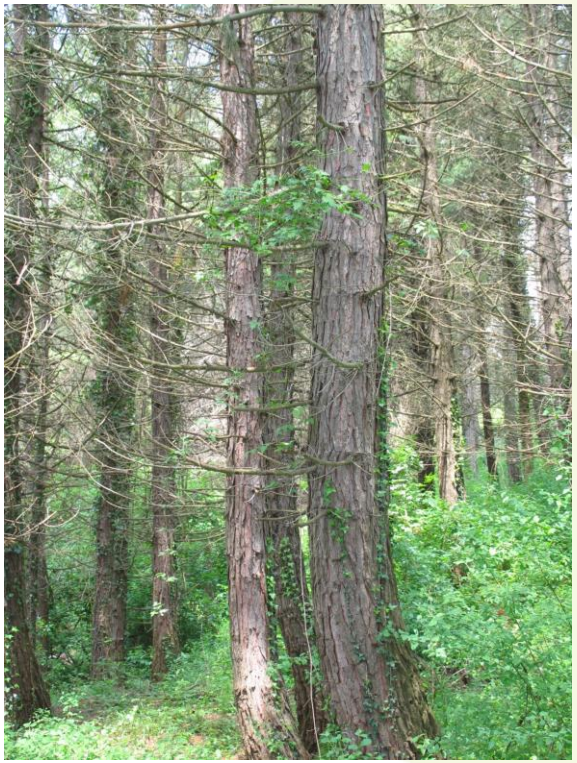
- the ‘mulching action’ exerted by the thick layer of the litter;

Cypress can thus **limit the risk of bush fires** involving litter or understory, compared to other tree species which, instead, favour the development of a continuous layer of understory vegetation.

STAND LEVEL

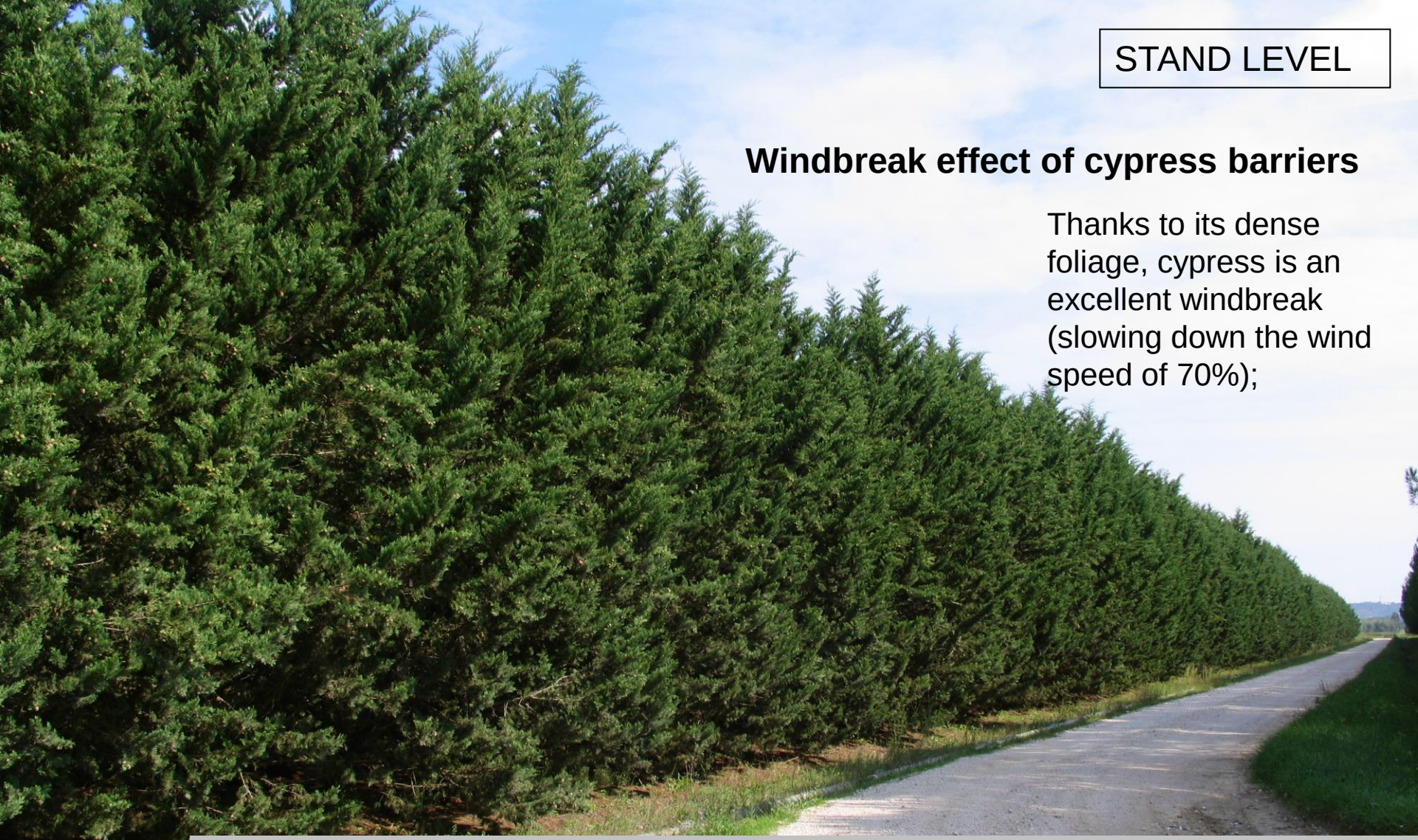
Self-pruning capacity
Understory development

Important features of the crown related to the severity of fire damages are: live/dead parts ratio, height of the insertion of the lower branches and the height of the understory.



The self-pruning capacity of cypress in rather dense stand creates a **clearance** between the ground and the crown, thus preventing (or reducing the possibility) the possible passage of the fire between the two layers.

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)



STAND LEVEL

Windbreak effect of cypress barriers

Thanks to its dense foliage, cypress is an excellent windbreak (slowing down the wind speed of 70%);

From a physical point of view, trees, such as cypress, with a dense crown (or in a ‘system’ of trees with crown vertically extended compenetrating each other like in a windbreak) the internal air exchange is slower resulting in a moist environment were the comburent circulation is reduced and that this characteristic can slow down the fire spreading.

EXPERIMENTAL CONCLUSIONS

Species that are **highly resistant to ignition** (high critical heat flux)

Species that are **slow to catching on fire** (high TTI)

Equipped by an **high ash content** that acts as a 'fire retardant' (mostly on the lower part of the crown)

Cypress has high potential as a species that would be useful to the control of forest fires in the Mediterranean environment and can be used as a **tool to reduce the intensity and speed of propagation of fire, and to contribute to the reduction of the fire risk**.

Cypress may be planted alongside access roads to woodlands, among plantations of other species, to make green low-combustible barriers, to slow down or prevent the spread of fire making it easier to control.

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Recommendations

In the frame of a capitalization project:

- Overcome prejudices and preconceptions on the use of a tree species to control wild fires

Cypress is not a resinous species in a broad sense (neither xylem, nor phloem or cambial region contains resins), resin production is induced in the bark region by wounds or fungal diseases only.

- In depth studies on the behaviour of forest species to fire (based not only on moisture content) represent a very important new tool in the forecasting of fire risk

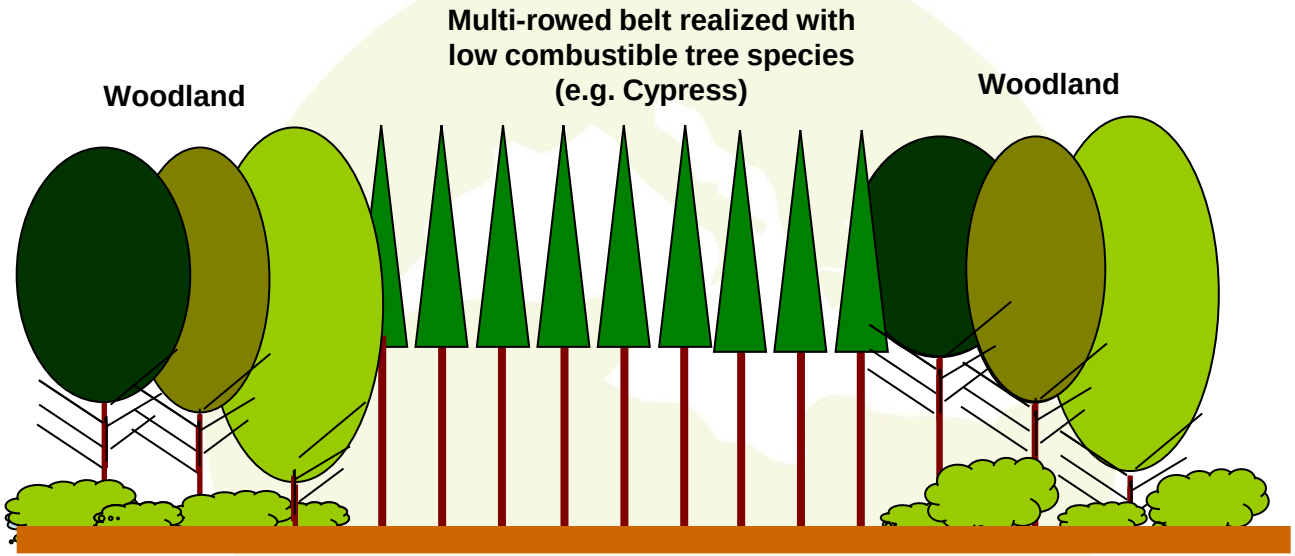
- Through forest management aimed at reducing the fire risk the protection of specific areas can be achieved (i.e. also at WUIs) using properly green barrier highly resistant to ignition and charecterized by a slow combustibilty

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

What was good?

- ✓ We have observed empirically what naturally occurred
- ✓ We realized that cypress has been used somewhat for 'fire protection' in the past
- ✓ We conducted scientific laboratory experiments to assess the flammability of cypress, establishing a strict and complete protocol that can be extended to other tree species

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)



Fire-break strips represent a loss of woody surface while green barrier can be an additional source of an high quality wood !!!

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

What is missing?

- ✓ Experiences at field level (in spite of several patently clear examples) of cypress barriers in the control of fire (how and how much)

That is why with the IMELSA of Valencia we are creating a series of cypress pilote plantations (barriers) around sensible areas

(Do not worry! we do not intend to set fire our plantations!)

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Thank you for your Attention….

INSTITUTE FOR PLANT PROTECTION – NATIONAL RESEARCH COUNCIL (IPP-CNR)

dellarocca@ipp.cnr.it

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)

Project cofinanced by the European Regional Development Fund (ERDF)