

Projet CypFire

Implementation of the « cypress system » as a green firewall

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Despite the progress made in recent years in the prevention of forest fires and the fight against them, the effects of climate change will lead to an increase in the threat. Vigilance must be maintained and new techniques tested. In this article, the authors present a trial of green firewalls constituted of Mediterranean cypress.

Introduction

Every year the number of wildfires and the surface area burned increase. We should ask ourselves why this is so despite the decades of research into the causes of wildfire and the efforts made for its prevention and control at regional, national and European levels (FAO, 2007). These negative figures (no. of fires/yr and area burned in ha/yr) necessitate further studies and innovative approaches based on the specific characteristics of the vegetation and on new techniques, with the aim of preventing outbreaks and the spread of wildfire.

This was the objective of the « Cypfire project: green fire breaks against wildfire – a feasible, ecological and economically-viable solution for saving Mediterranean regions » (2010 - 2013), co-financed by the FEDER of the European Union's Med programme for regional cooperation and developed in collaboration with partners from nine Mediterranean countries: Italy, France, Portugal, Greece, Malta, Spain, Tunisia, Israel and Turkey.

1 - INIA : Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria
CIFOR : Centro de investigación forestal

In matters of wildfire, preventive silviculture encompasses a corpus of rules and strategies aimed at incorporating into forestry management the installation of woody barriers procuring a lower level of inflammability, thus making the spread of fire more difficult. The modification of the structure of the vegetation is obtained by the diversification of the species used, the forest stands themselves and the creation of gaps, and by the partial or total elimination of fuel in the critical parts of the forests and woodlands. The most common form of intervention is the making of traditional firebreaks, both within and outside the confines of the forest stands, in the most suitable zones which include valleys, ravines, watercourses, ridges, the urban-rural-forest interface, agricultural and grazing land, areas preferentially for leisure, refuse dumps, industrial and mining facilities, communications and service infrastructure (power lines, gas pipelines, railways, motorways and roads) as well as in very sensitive areas characterised by a high risk of wildfire, their heritage value or protection zones.

The installation of forest structures thanks to fuel modelling which limits and reduces the speed of spreading (models 8 and 9 of the BEHAVE system) is achieved by different types of action carried out not only in the linear plantations (hedges) but within the stands themselves, in order to create vertical and horizontal discontinuity in the fuel material; and, also, by planting less inflammable species which also limit the growth of bushy undergrowth.

Picture 1:

An overview of an adult stand of *Cupressus sempervirens* var. *horizontalis* at rural-forest interface producing a linear, heterogeneous landscape on the basis of the « Cypress system » Florence, Italy.
Authors B. Moya & J. Moya.



Properties of the Mediterranean cypress

The varieties with a horizontal habit of growth can be used for fire breaks, thus constituting what we shall call the « Cypress system » which offers a series of botanical, ecological and environmental features that make it particularly advantageous in establishing structures of vegetation that are more resistant to forest fires. The use of this system, in conjunction with the principles underlying preventive silviculture, is compatible with, and can be integrated into, other actions.

The properties of the Mediterranean cypress (*Cupressus sempervirens* var. *Mediterranea horizontalis*) were identified and highlighted by laboratory studies on inflammability and burning characteristics at particle level carried out by the Institute for the Protection of Plants (IPP) in Florence and the INIA - CIFOR¹ in Madrid. The main results were: high moisture content throughout the year, poor inflammability, a shorter flame, the VOC (volatile organic compounds) emitted during combustion do not catch fire, poor inflammability of the dead matter etc.

Considering the trees themselves, the varieties of Mediterranean cypress produce a smaller amount of dead matter than other Mediterranean species. Furthermore, they are more compact and have a greater capacity for retaining moisture. In addition to these characteristics, this cypress shows little tendency to shed its growth, retaining its lower living branches, which means less presence of dead branches. And its crown is dense.

Considering the stands, plantations and small cypress woods and copses, what can be observed is little presence of bush and shrub biomass, great uniformity and compact growth in the forest structure, and the species' well-known effect as a wind break.

At the level of both tree and stand, the limited accumulation of fuel on the ground is an important factor because it contributes to the existence of forest stands with low levels of combustibility which hinder the spread of surface fires, known as « motor fires », while at the same time it reduces the maintenance costs (short growth period) of traditional fire breaks.

At the ecological level, it should be noted that the species is adapted to the xero-, meso- and thermo-Mediterranean zones and

to irregular patterns of rainfall. The cypress is classed as xerophilic; though it is very adaptable, and can grow fast in favourable conditions, it shows great tolerance to heat and resists low temperatures down to -10°C. It is indifferent to the nature of the soil and to the pH and can grow on poor, arid, barren, deteriorated land. In addition, *Cupressus sempervirens* is not an invasive species in the Mediterranean context where it was introduced thousands of years ago.

Setting up an operational «Cypress system» as a firewall

The green firewalls of the «Cypress system» incorporate all the characteristics and properties of the cypress when planted in clumps or groves which are structures of vegetation with the lowest degree of combustibility and with the ability to hinder the spread of wildfire.

The trees used are selected varieties of *Cupressus sempervirens* var. *horizontalis* whose branches grow out of the trunk at angles between 45° and 90°. These varieties are resistant to the cypress canker (*Seiridium cardinale*) and have been selected



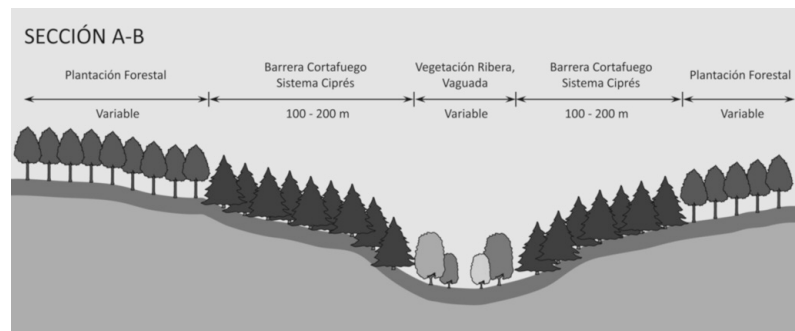
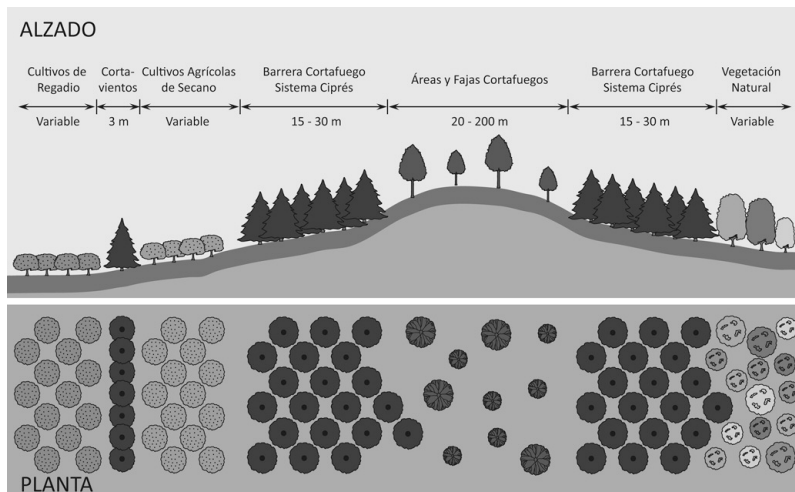
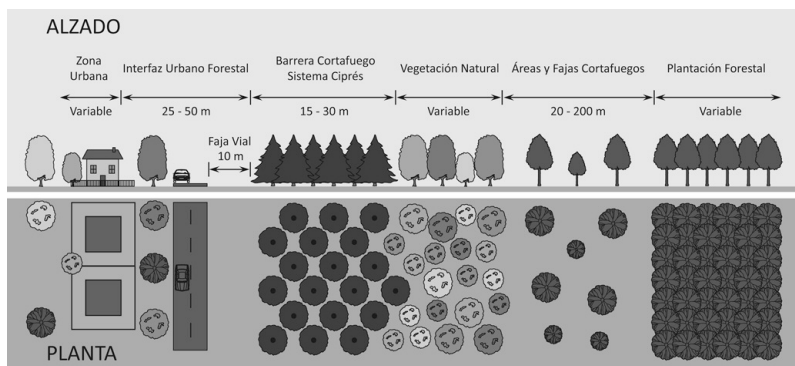
Picture 2:
View of a plot in the CypFire project. Notice the plot has very little dead matter and biomass.
Authors B. Moya & J. Moya.

for their capacity to adapt to the soil and the various climatic and environmental conditions prevailing in the different parts of the Mediterranean Rim (DANTI *et al.*, 2013). Selection related to resistance to diseases is very important because diseased trees have a very low moisture content, dead branches in their canopy and resin on the branches and trunk, all factors making them more inflammable.

Table I (below):
Main characteristics of the «Cypress system» in relation to forest fire, at the levels of particle, tree and structure of the vegetation.
Authors G. Della Rocca, R. Danti, P. Raddi, B. Moya, J. Moya.

Main features of the «Cypress system» (*Cupressus sempervirens* var. *horizontalis*) favourable against fire risk

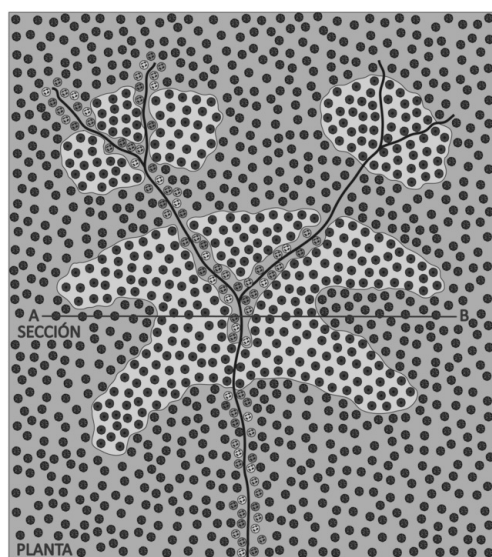
ORGAN LEVEL <i>(laboratory tests)</i> <i>Compared to other Mediterranean tree species</i>		TREE LEVEL <i>Knowledge and post fire observations in natural forests or in cypress stands</i>	STAND LEVEL <i>(including multiple rows)</i> <i>Knowledge and post fire observations in natural forests or in cypress stands</i>
Biomass	Litter		
-Higher water content	-Higher water retention	-Adaptation to warm and dry climate	-Interlocking crowns
-Longer ignition delay	-Higher compactness	-Ability to grow well in any soil	-Ability to form effective windbreak with selected varieties
-Higher critical heat flux	-Higher ash content	-Low retention of dead material in the crown (var. <i>horizontalis</i> only)	-High self-pruning ability in dense stands (vertical fuel discontinuity)
-Higher ash content	-Longer ignition delay	-Crown compactness	-Ability to maintain a deep crown from the canopy to ground level (if planted as 'screen' in outer rows)
-The volatile organic compounds (VOC's) do not participate in the ignition process	-Lower flame height in the combustion	-No crown diebacks nor resin exudation (using diseases resistant selected varieties)	-Reduced development of an understory (vertical fuel discontinuity)
-No significant differences in the flammability at different heights and orientations of the crown		-High resilience of the areas affected by dehydration of the crown	- <i>C. sempervirens</i> var <i>horizontalis</i> , higher screen effect to heat flux
-Lower flame height in the combustion		- <i>C. sempervirens</i> is a bradyspory species. Cones, are not projected out (like firebrands) during seed dispersal induced by the heat of fire.	
		The cypress is part of the culture and landscape of the Mediterranean	
		-The cypress is a native or naturalized species in the Mediterranean countries.	
Cypress system firewalls are not hedges. The green firewall should be constituted with selected varieties, growing into natural shape, never trimmed or pruned.			
RECOMMENDATION : remove the inner dead biomass (leaves, twigs, branches) of all hedges.			



From top to bottom:
Fig. 1: Proposal for a « Cypress system » plantation of a green firewall at a forest - residential interface.

Fig. 2: Proposal for a « Cypress system »plantation of a green firewall at a rural-forest interface and fire break areas.

Fig. 3 & 4: Proposal for a « Cypress system »plantation of a green firewall in areas with valleys and wooded ravines.
B.Moya - J. Moya.



In the linear forms of the « Cypress system », the distance between the trees at planting is between 3m and 5m along the row. The distance between the rows is also from 3m to 5m, with the trees staggered from row to row in order to maximise their screening effect. The minimum number of rows, that is to say the width of the structure, is five.

This kind of linear structure of the « Cypress system » can be applied or adapted for the reinforcement of fuel breaks within or outside stands, on the cleared shoulders of the forest tracks or strategic clearings (or fire-fighting access cuts). But they can themselves constitute a true firewall within or outside natural or planted stands, as well as at the urban-rural-forest interface, on agricultural and grazing land, forested areas for leisure and other activities, near refuse dumps, industrial and mining facilities, communications and service infrastructure...

The « Cypress system » scheme of grouped linear plantation can be applied to mass plantings but also to irregular natural formations, on condition that the continuity of the dense living screen of cypresses which evolve into clumps remains intact. In any event, the « Cypress system » pattern of planting must be adapted to the lie of the land and be integrated into the landscape and forests in a natural way.

Such firewall formations of the « Cypress system » can be useful for establishing buffer zones which hinder or prevent the rapid progress of wildfire along the valleys, tracks and ridges which, by their elongated configuration, facilitate the penetration, spread and transmission of wildfire in the surrounding environment, whether wooded or agricultural, connecting formations of massed vegetation that are normally isolate from each other.

The aim of implementing the « Cypress system » at strategic points is to delay the propagation of ground fire and crown fire. In this respect, the trees of selected varieties of Mediterranean cypresses with a horizontal habit of growth retain their natural habit throughout their life, forming an uninterrupted canopy from the ground up to the tree tops that acts as a screen. The ability to function as a firewall derives from the sum of all the combined properties of the individual trees that form the wall. The structure and the density of the « Cypress system »



plantings allows sufficient passageway to people and animals. This system is totally different from ornamental cypresses in its aims, context, varieties, adaptation and arrangements, plantation and maintenance.

In all cases, the implementation of the fire breaks is done on the basis of inflammability cartography and dynamic risk mapping and as a function of the characteristics of the plant cover, use of the land, topography, fire risk, protection zones etc. Its implementation must follow the general planning principles which govern the fire protection networks linked to fuel breaks, in accordance with the legislation currently in effect. Thus, the implementation can be incorporated into the areas subjected to treatment of their combustible fuel as a way of limiting the spread of wildfire.

Experimental pilot sites

The necessity for transposing the result to a bigger scale and then to apply them drove the Deputacion of Valencia, via its Outstanding Trees Service and the publicly-owned IMELSA company, to design and plan the first experimental plantations of the « Cypress system » firewalls as a way of furthering research and improving the efficacy of the fight against wildfire.

To this end, IMELSA set up pilot areas, located in different parts of the Valencia Region, in which 10,000 cypress selected by the IPP were to be tried out in green firewalls but also for their adaptation to desertification, for wood production and wind breaks, for landscape and gardening, and for

the conservation of the genetic diversity of cypress species and varieties from around the world. The trees are due to arrive in 2014-15.

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Pictures 3 & 4:

The pathways of wildfire spreading through gorges and valleys, locations where installation of a « Cypress system » green firewall is recommended.

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Picture 5:

Reproduction of selected varieties of *Cupressus sempervirens* var. *horizontalis*, IPP-CNR in Florence.
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Editor's note

It seems useful to us to inform our readers of the following points:

- interest in the cypress for limiting the spread of wildfire subsequent to the survival of a few cypresses at the heart of the big forest fire at Andilla in Spain (2012) has been the subject of a lively debate in the scientific community. Other reasons have been proposed to explain why this stand was spared by the fire ;
- though cypresses are widely used in Turkey to reinforce fuel breaks, in France feedback indicates the danger of cypress hedges at the forest – settlement interface ;
- scientific research on the production and emission of volatile organic compounds by conifers (VOC) has shown that these species produce polyphenolics which spread into the air, creating inflammable layers, in contrast to the oaks which retain these substances in their leaves.

Hence, as the authors of this article suggest, experimentation and research is still necessary in this field. Our magazine will gladly relay the progress that anybody reports.

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Summary

The European project «CypFire» conducted study research and management of experimental areas of cypress located in 9 countries around the Mediterranean Rim, analyzing the behavior and functionality of the green firewalls of Mediterranean cypress; understory characterization in cypress stands; the assessment of morpho-physiological traits; and studies of laboratory flammability and combustibility of living parts and dead matter. The knowledge generated has provided valuable information for defining the basis for implementing the green firewall barriers of the «Cypress system», based on Mediterranean cypresses, and for action to reduce the fuel load and to delay the spread of fire, in line with the principles of preventive silviculture.