Transformation of *Castanea sativa* coppice forests by selective stump removal: chemical, physical and mechanical methods

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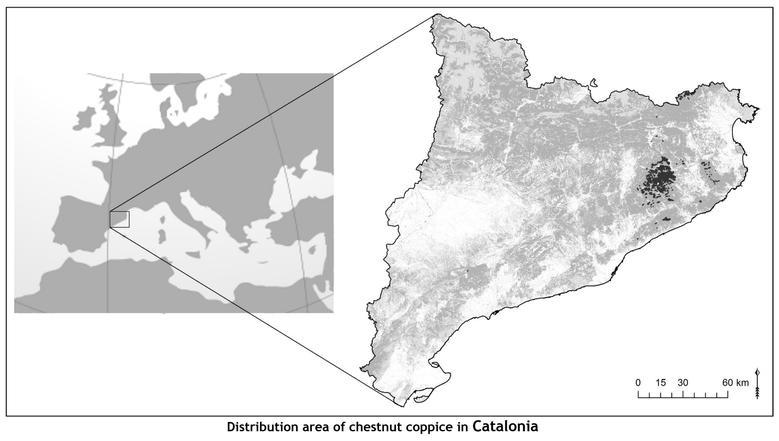
Chestnut coppice in Catalonia

Chestnut coppice covers near 13,000 ha in Catalonia (NE Spain), in a mild and rainy Mediterranean climate. **It has been managed traditionally as low coppice**, mainly for **poles production**. However, since the middle of the XX century the species has been intensely affected by the **chestnut blight**, which reduces the quality and value of the timber. At present, there is an increasing interest in the transformation of chestnut coppices into low-density forests (100 trees/ha) with main objective of fruit production, which is perceived by forest owners as an alternative in low site quality areas. However, this transformation is not an easy task, since it requires an intense selective removal of most of the existing stumps, being expensive and not always a successful treatment.



Distribution area of chestnut coppice in Catalonia

Objectives

- **To determine the effectiveness of several methods of stump removal** (3 chemical treatments, 2 physical and 2 mechanic ones), to achieve a cost-effective selective elimination of *Castanea sativa* stumps.
- **To assess the phytotoxicity side effects of the chemical treatments** to the remaining stumps and also to other broadleaved species naturally present in the chestnut coppice.

Chestnut blight: hypovirulent and virulent cankers

Abandoned coppice. Density is over 2000 stumps/ha

Grafting selected resprouts in the 100 remaining stumps/ha

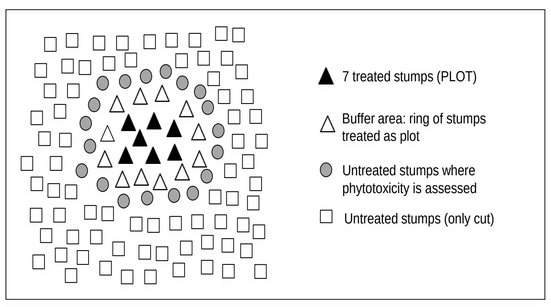
Mature chestnut orchard for fruit production

Materials and Methods

The study was conducted in the Montseny range area (Catalonia, NE Spain). We tested **6 methods of selective removal of chestnut stumps: (i) 3 chemical treatments** (applying herbicide to the freshly cut stump toghether with an inert dye- Roundup© Ultra Plus-ROUNDUP, Tordon22©-TORDON and Garlon GS©-GARLON), **(ii) 2 physical treatments** (stump covering with black polyethylene foil-PLASTIC and with wood chips-WOODCHIP) **and (iii) 2 mechanic treatments** (stump uprooting-UPROOT and in situ fragmentation with a digger-FRAGMENT). Three blocks with plots of 7 stumps for each treatment + control were established. All stands were 21 years old resprouts. The whole stand was clearcut previously to the application of the treatment. Treatments were applied by October-December 2014.

We evaluated the effectiveness of the treatments (**resprouting intensity, length and basal width of sprouts in the following spring**). A Kruskall-Wallis and a pairwise U-Mann-Whitney for all possible pair of treatments were used to detect differences among treatments for the three measured variables.

Phytotoxicity side-effects in untreated chestnut stumps were assessed by means of the level of damage and distance to the nearest treated stump.



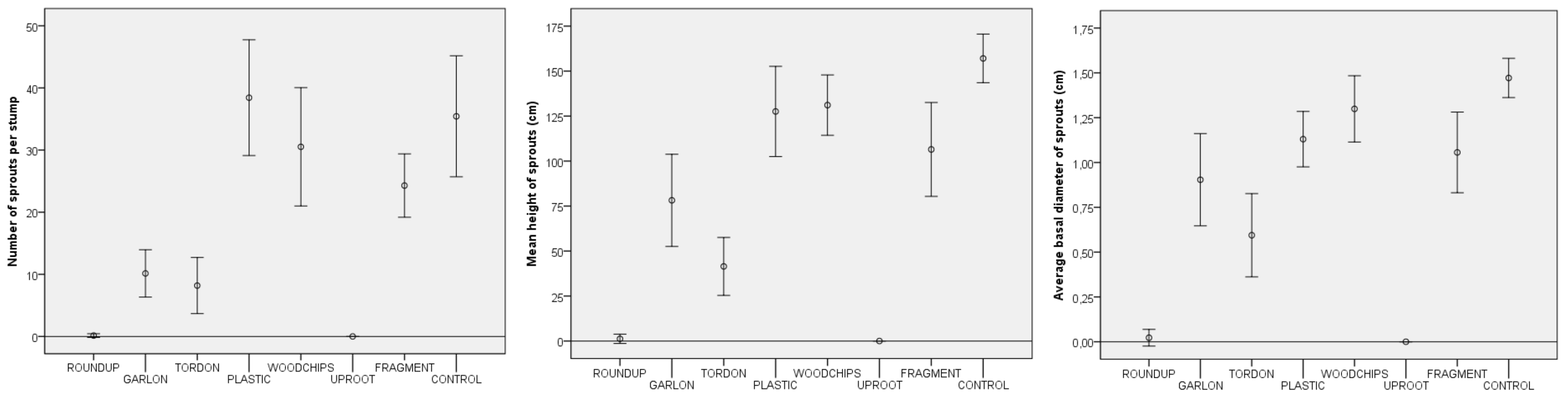
Distribution of the stumps in each plot

Different methods for stump removal: chemical (ROUNDUP, TORDON and GARLON) (upper left); mechanical (UPROOT and FRAGMENT) (UPPER RIGHT) and physical (PLASTIC and WOODCHIP (lower)

Results

I. Effectiveness of the treatments

Regarding the number of sprouts per stump, **ROUNDUP and UPROOT were the most effective** (number of sprouts per stump was practically 0). GARLON and TORDON were a little less effective (around 10 sprouts per stump). The rest of treatments (WOODCHIP, PLASTIC and FRAGMENT) have not presented significant differences with the "CONTROL" nor between them (around 25-35 sprouts per stump), so it can be stated that these methods are not effective enough for remove stumps of chestnut in our conditions. Mean basal diameter and length of sprouts followed a similar pattern.



H-statistic of the U-Mann Whitney pairwise test for "number of sprouts per stump one vegetative period after the treatment". (*): p>0.001; (NS): non significant (p>0.05)

	UPROOT	WOODCHIPS	FRAGMENT	ROUNDUP	TORDON	GARLON	PLASTIC
CONTROL	35,164 (*)	0,589 (NS)	2,208 (NS)	34,493 (*)	20,046 (*)	17,296 (*)	0,293 (NS)
UPROOT		35,161 (*)	32,601 (*)	1 (NS)	19,429 (*)	23,424 (*)	35,161 (*)
WOODCHIPS			0,335 (NS)	34,337 (*)	17,847 (*)	13,989 (*)	124,708 (*)
FRAGMENT				476,265 (*)	402,619 (*)	390,49 (*)	2,205 (NS)
ROUNDUP					17,496 (*)	21,578 (*)	34,49 (*)
TORDON						1,117 (NS)	24,306 (*)
GARLON							21,713 (*)

Phytotoxicity side-effects in untreated chestnut stumps neighboring to treated plots. 0: no damage, 1: Slight damages, 2: Medium damages; 3: severe damages; 4: complete death

Herbicide	Total stumps surveyed	Number and % of stumps for each class of damage				
		0	1	2	3	4
ROUNDUP	86	74 (86%)	11 (13%)	1 (1%)	0	0
TORDON	54	32 (59%)	9 (17%)	13 (24%)	0	1 (2%)
GARLON	54	45 (83%)	2 (4%)	5 (9%)	1 (2%)	1 (2%)

Number of stumps of other broadleaved species monitored for effects of phytotoxicity. Qii: Quercus ilex subsp. ilex; Qp: *Quercus pubescens*; Au: *Arbutus unedo*; Ap: *Acer pseudoplatanus*; Fe: *Fraxinus excelsior*; Pa: *Prunus avium*.

Herbicide	Species					
	Qii	Qp	Au	Ap	Fe	Pa
ROUNDUP	25	2	2	1	2	1
TORDON	8			1		
GARLON	8				1	2

II. Phytotoxicity

Treatments with herbicides showed a low phytotoxicity side-effects in untreated chestnut stumps neighboring to treated plots, being ROUNDUP the less phytotoxic treatment. No correlation among class of damage and distance to the nearest treated stump was detected.

Conclusions

Chemical treatments are highly effective compared with physical or mechanical and would be suitable for selective stump removal of *Castanea sativa* coppice forests in areas of high slope, where the uprooting is not possible due to the difficulty of access of the heavy machinery. With the help of inert dyes, efficiency and safety can be improved by avoiding drift contamination and knowing exactly where the chemical is being applied.

The **low phytoxicity to neighbor untreated stumps that has been found allows for a selective elimination of the stumps**, which is necessary if the general management goal is to keep some stumps alive that will be grafted later for fruit production.

References:
Beltrán, M., Vericat, P., Piqué, M., Farriol, R. 2013. Models de gestió per als boscos de castanyer (*Castanea sativa* Mill.): producció de fusta i fruit. Sèrie: Orientacions de gestió forestal sostenible per a Catalunya (ORGEST). Centre de la Propietat Forestal. Departament d'Agricultura, Ramaderia, Pesca, Alimentació i Medi Natural. Generalitat de Catalunya, Barcelona. 45 p.

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