Comparing Pinus halepensis and Pinus pinea post fire mortality

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Background: Mediterranean pines have developed different strategies to cope with fire. In that respect, *Pinus halepensis* and *Pinus pinea* have been classified as fire embracer and fire tolerater species respectively (Keeley, 2012). Preventive sylviculture needs to take into account the most recent knowledge on fire ecology of trees to implement successful guidelines. Self protection objective, the global post-wildfire survival of trees at the stand level, is certainly the most demanding option of preventive sylviculture.

Questions: Does differences in fire ecology of pines, justify developing specific preventive sylviculture guidelines?

Experimental fire under pine plantation (July 2011)

Methods: An experimental fire has been carried out in early July 2011 in a mixed *P. halepensis* - *P. pinea* plantation of 16 years old, 20 km from Avignon, France. Five years before burning trees were pruned at 2 m high and stand density was reduced to 1500 stem/ha with even proportion of each species. *P. halepensis* were higher and bigger than *P. pinea* (Table 1). Undergrowth fuel was replaced by straw uniformly spread with a 10 t/ha load. Fire weather conditions were severe (IFM >100) with dry and hot (27°C) conditions and gusty wind (55 km/h). Fire was characterized by measuring fire rate of spread, and flame geometry. Fire temperatures were estimated using thermometer strips distributed along 30 vertical gradients installed in pine crowns (2, 3, 4 and 5 m AGL). Immediate fire effects on pines were measured using both crown and bole damage indicators. Post fire pine mortality was monitored until stabilization in early 2013.

Table 1. Mean value (x), standard deviation (Std Dev.) and range for diameter at breast height (DBH, cm), tree height (H, m), percent of the crown volume scorched (CVS, %) and percent of bole char length (BLC,%) *P. halepensis* and *P. pinea*.

	P. halepensis (n=123)			*P. pinea* (n=119)		
	x	Std Dev.	Range	x	Std Dev.	Range
DBH (cm)	13,9	4,3	6,5-32,8	13,0	3,1	6,5-22,3
H (m)	10,1	1,3	6,5-13,3	7,9	0,8	6,0-10,1
CVS (%)	80,6	25,9	5-100	56	29,6	0-99
BLC (%)	7,0	2,7	0-13,7	6,5	2,5	0,5-11,8

Results and discussion: Fire rate of spread was 0.18 m/s, and mean flame heights were 1-1.2 m and 1.5-2 m for flank fire and head fire respectively. Immediately after fire, mean crown volume scorched was higher on *P. halepensis* (81%) compared to *P. pinea* (56%). Crown scorched heights were consistent with estimated temperature levels according to the lethal temperatures usually reported in the literature. In particular, when temperature levels indicated by thermometer strips at 5 m above ground level were higher than 65°C, scorching was always above 5 meters.

Table 2. Classification table comparing observed and predicted post-fire status of 123 *P. halepensis* and 119 *P. pinea* individuals using four logistic regression models from Rigolot (2004) predicting the probability of mortality as a function of crown volume scorched only (ph1 and pp1) and probability of mortality as a function of crown volume scorched and mean bole char length (ph2 and pp2).

		Observed status							
Species		*Pinus halepensis*				*Pinus pinea*			
Models		ph1		ph2		pp1		pp2	
		Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
Predicted status	Dead	87	16	87	14	0	7	0	0
	Alive	6	14	6	16	0	112	0	119
Success (%)		82%		84%		94%		100%	

Post fire crown scorch on P. pinea (right) and P. halepensis (left).

Eighteen months after fire, *P. halepensis* mortality rate was 76% whereas no mortality was recorded for *P. pinea*. Specific mortality patterns are in agreement with published post fire mortality models using fire damages to crown and bole as explanatory variables (Rigolot, 2004). Success in predicting post fire mortality (Hits and Correct rejections) is higher than 80 % and 90 % for *P. halepensis* and *P. pinea* respectively (Table 2). The higher heat resistance of *P. pinea* compared with *P. halepensis* is mainly explained by morphological differences like thicker bark at a given diameter of *P. pinea* and bigger needles offering a good heat protection to buds (Rigolot, 2004).

Conclusion: High post fire survival of *P. pinea* under severe fire conditions suggests this species is a good candidate for preventive sylviculture including implementation of self protection objective in relatively young stands. Preventive sylviculture has to adapt to the specific fire ecology of pines.

Compared post fire mortality on P. pinea (right) and P. halepensis (left)

References

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