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Laboratory characterization of firebrands involved in spot fires

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Abstract

• ***Introduction*** Wildfires are considered the most important disturbance in the Mediterranean Basin, and some are propagated over long distances due to lift-off and ignition of firebrands.

• ***Objectives*** To improve our knowledge of firebrands involved in spotting fires, flammability characteristics of eight types of firebrands commonly generated by wildfires in Southern Europe were determined under laboratory conditions.

• ***Results*** All the firebrands tested showed 100% ignition frequency but with a wide range of time to ignition and flaming duration. Weight loss during combustion was exponentially related to time, and there was a decrease in the ratio of the weight at temperature T to the initial weight with increasing temperatures. In our experimental conditions, there was a significant effect of fuel moisture content on time to ignition, flaming duration, combustion and thermal decomposition. On the basis of the characteristics analysed, three firebrand groups have been identified in relation to spotting: heavy firebrands with ability to sustain flames, efficient for long-distance spotting (pine cones); light firebrands with high surface-to-volume ratio, efficient for short-distance spotting (leaves and thin barks); and light firebrands with low surface-to-volume ratio, efficient for short and, occasionally, long-distance spotting (all the other types of firebands).

Keywords Firebrand · Fire behaviour · Flammability parameters · Wildfire · Ember

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1 Introduction

In the Mediterranean Basin, wildfires alter thousands of hectares of forest and shrubland ecosystems (JRC 2009). Some of these wildfires are propagated over long distances due to the spotting mechanism. Spotting is frequently related to crown fires; it complicates wildland fire control and is one of the main causes of loss of homes in wildland-urban interface areas. Spotting is a fire propagation mechanism which spreads fire by producing firebrands that are carried up in the rising convection column and then drift and fall on remote sites. Despite its important role in fire spread, spotting has rarely been modelled. McArthur (1967) produced an empirical model that predicts mean spotting distance for *Eucalyptus* forests. Albini developed several mathematical models to predict potential spot fire distance from torching trees (Albini 1979), a burning pile (Albini 1981) and a wind-driven surface fire (Albini 1983). Gardner et al. (1999) reviewed the main fire models and showed that most simulations do not include the influence of firebrands on fire pattern. Hargrove et al. (2000) developed a fire model (EMBYR) incorporating the effects of fuel moisture and wind on fire ignition and spread,