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Comparing the effectiveness of suppressants used for direct attack

A methodology for testing and comparing the direct attack effectiveness of wildfire suppressants has been developed. The method determines the minimum volume of suppressant required to extinguish 'standard' fires in the CSIRO Pyrotron. This measure can be used to quantify and compare effectiveness of different suppressants.

Suppressants

Suppression chemicals added to water are used in a variety of bushfire attack and protection roles, including direct attack from aircraft. A range of products are used, however there is no standard method for evaluating or comparing their effectiveness for extinguishing bushfire flames. While observations of their use can be made in the field, the variability in conditions make direct comparisons difficult (Plucinski and Pastor 2013). With the wide range of suppressants available, each with its own set of advantages and disadvantages, an objective method of assessment was required.

Evaluation methodology

After investigation of various international approaches used to test suppressants and retardants, a suitable methodology was developed. The method involves suppressants being applied directly on the flaming fronts of standardised laboratory fires burning within the CSIRO Pyrotron (Sullivan et al. 2013). The Pyrotron provides a means for ensuring consistent testing conditions and enabling the detailed measurements required for comparative analyses.

The standard fires are burned in a 3 × 1.5 m fuel bed of eucalypt litter (12 t/ha, 7% moisture) with an air speed of 1.6 m/s (equivalent to 18 km/h in the open). This setup provides repeatable fire behaviour representative of wildfire conditions (Mulvaney et al. 2016). Fires are ignited across the width of the fuel bed and allowed to develop for two metres before suppressants are applied at a fixed location. Suppressants are delivered through a purpose-built pressurised system mounted above the burning fuel, with small volumes repeatedly applied to the headfire until fire spread is stopped (Figure 1). Residual burning is monitored to ensure that head fire flames are fully extinguished with subsequent applications delivered when required.

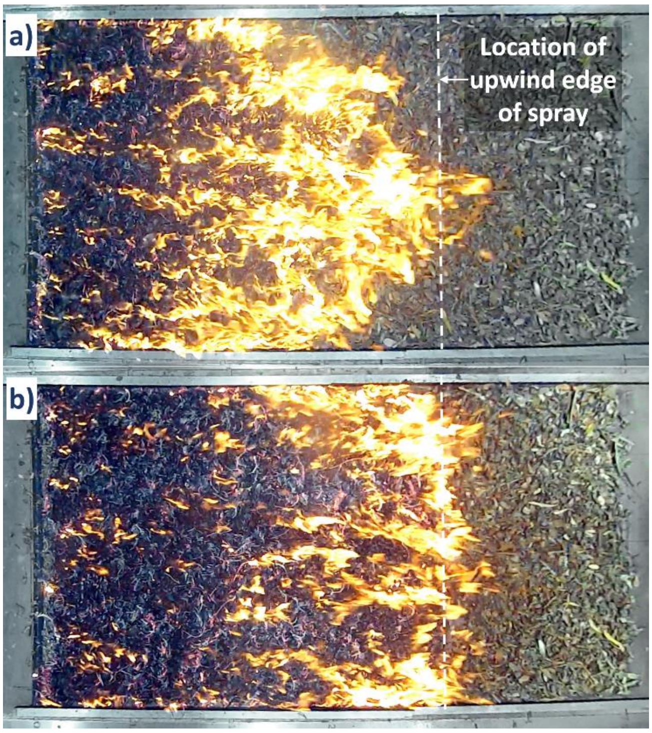

Figure 1. Overhead view of a suppressant evaluation fire (a) immediately before suppression and (b) during suppression application.

Performance assessment

An important aspect of any evaluation is consistent and repeatable tests to ensure robust results. Analysis of testing using a small selection of available suppressants (including water and foam) at a single concentration show that tests conducted with the same suppressant mixes have very low variability (coefficient of variation ~10.8%, Plucinski et al. 2017) and thus high reliability (Figure 2).

In order to minimise any minor uncontrolled variations that may occur as a result of differences in fuel and ambient conditions between tests, results of repeated tests (i.e. replicates) can be normalised, producing relative values for comparison. The example results presented in Figure 2 show statistically significant differences in the effectiveness of the different test suppressants as expressed as the volume of suppressant required to extinguish the standard fire.

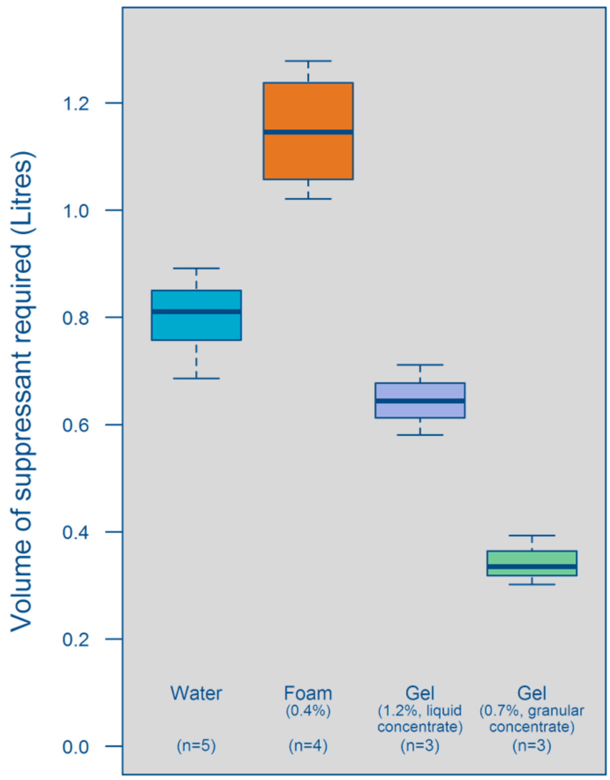

Figure 2. Plots showing the normalised distribution of the volume required for the extinction of standard fires using some example suppressants.

The performance of the example suppressants was influenced by their tendency to drift in the air flow. Those that were prone to drifting became dispersed and required greater volume to extinguish the fire front.

Further considerations

The selection of suppressants for operational use needs to consider a range of issues in addition to effectiveness. These include cost, toxicology, ease of preparation and application, and holding time. Holding time (the time between the successful application of suppressant and the treated area re-igniting) provides an additional measure of suppressant effectiveness and was not considered in this methodology. While of secondary importance in direct attack, holding time is important in situations where there is potential for re-ignition from residual burning in coarse fuels and when there is a delay between application and ground suppression.

The methodology detailed here is designed to produce an efficient and independent evaluation of the effectiveness of suppressants in standardised conditions. The degree to which it represents conditions in the field needs to be quantified.

Further reading

Plucinski, MP, Sullivan, AL, Hurley, RJ (2017) A methodology for comparing the relative effectiveness of suppressant enhancers designed for the direct attack of wildfires. *Fire Safety Journal* **87**, 71-79.

References

Mulvaney, JJ, Sullivan, AL, Cary, GJ, Bishop, GR (2016) Repeatability of free-burning fire experiments using heterogeneous forest fuel beds in a combustion wind tunnel. *International Journal of Wildland Fire* **25**, 445-455.

Plucinski, MP, Pastor, E (2013) Criteria and methodology for evaluating aerial wildfire suppression. *International Journal of Wildland Fire* **22**, 1144-1154.

Sullivan, AL, Knight, IK, Hurley, RJ, Webber, C (2013) A contractionless, low-turbulence wind tunnel for the study of free-burning fires. *Experimental Thermal and Fluid Science* **44**, 264-274.

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