

REPLY TO Santín ET AL.:

# Viscoelastic retardant fluids enable treatments to prevent wildfire on landscapes subject to routine ignitions

Eric A. Appel<sup>a,1</sup>, Craig S. Criddle<sup>b</sup>, Jesse D. Acosta<sup>c</sup>, and Anthony C. Yu<sup>a</sup> 

Our recent paper (1) reports the development and pilot-scale validation of viscoelastic carrier fluids for ammonium polyphosphate (APP), the primary retardant used in wildland firefighting, to improve retention on common ignition-prone vegetation to protect through environmental exposure.

In response to our paper, Santín et al. (2) state that while our approach is worthy of further exploration we did not provide sufficient support for suitability of these fluids at large scale. Specifically, they question the 1) environmental impact, 2) effectiveness through weathering, 3) economic feasibility, and 4) effectiveness in combating approaching wildfire.

Several of Santín et al.'s (2) critiques arise from a severe misunderstanding of the intended use of our retardant fluids, highlighted by their suggestion that preventative treatments would need to cover half of California and combat high-intensity wildfires. Our retardant fluids were designed for prevention of wildfires at locations where ignitions are historically known to originate. While it is true that “fire-threat” maps indicate that much of the state is endangered by severe wildfire events, 84% of wildfires are strongly localized adjacent to roadsides and utilities infrastructure—“high-risk” landscapes subject to routine ignitions (figure 1 in ref. 1). Thus, prophylactic treatment of a small amount of land, such as a 20-ft-wide treatment adjacent to the roadside, could potentially prevent a majority of wildfires by averting them at their source.

With respect to environmental impact, the biodegradability and toxicity assays we conducted (figure 4 in ref. 1), while not comprehensive, are commonly used to assess novel materials. More extensive evaluation of the environmental impact of our retardant fluids will be described in a forthcoming paper. Currently, APP-based

retardants are widely used worldwide in emergency suppression strategies (3–5). Importantly, our approach to preventative treatments enables systematic, careful consideration of local factors to be made before application, decreasing overall retardant usage.

In regard to weathering, Santín et al. (2) overlook our pilot-scale studies (figure 6 in ref. 1), where treated vegetation of two varieties was subjected to simulated rainfall and 6 wk of environmental exposure—direct ultraviolet irradiation, wind, and temperatures routinely above 35 °C. This simulated rainfall (1.27 cm) exceeds the maximum amount typically experienced in wildfire-prone regions in California during peak fire season (6). We demonstrate that our retardant fluids exhibit appropriate mechanical properties to maintain efficacy through weathering.

In response to economic feasibility, the facile manufacturing of these retardant fluids from commodity materials commonly used in food, cosmetics, and industrial applications suggests they could be directly competitive on a cost basis with commercial wildland fire retardants (7, 8).

Finally, as we aim to stop ignitions at their source, treatments would not be subject to high-intensity wildfires. While our retardants are completely effective in grass, our study corroborates the literature consensus (9–11) that APP-based retardants become ineffective in energy-dense vegetation once fire matures. It is for precisely this reason that we seek to avert ignitions at their source.

We appreciate the opportunity to highlight how our paper addresses these important concerns. Our study describes a critical tool to reduce the incidence of wildfires that complements the many approaches already used by fire managers worldwide.

<sup>a</sup>Department of Materials Science & Engineering, Stanford University, Stanford, CA 94305; <sup>b</sup>Department of Civil & Environmental Engineering, Stanford University, Stanford, CA 94305; and <sup>c</sup>Department of Natural Resources Management & Environmental Science, California Polytechnic State University, San Luis Obispo, CA 93407

Author contributions: E.A.A., C.S.C., J.D.A., and A.C.Y. wrote the paper.

Competing interest statement: A.C.Y. and E.A.A. are listed as inventors on a patent describing the technology reported in this reply. On 25 October 2018, J.D.A. and E.A.A. founded a company called LaderaTECH, which has licensed the technology from Stanford University.

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<sup>1</sup>To whom correspondence may be addressed. Email: eappel@stanford.edu.

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