Retardants with residual fire protection and soil nutrition benefits

By Greg Butler, SANTFA Research & Development manager

STUBBLE retention has emerged as a key ingredient in modern and sustainable Australian grain farming systems. But over our typically long and hot conditions pre and post harvest, retaining stubble comes with the risk of fire. For the past four years SANTFA has been researching some mitigating strategies and products to help lessen the risk of devastating crop and stubble fires.

After the Pinery fire in South Australia's Mid North in November 2015, we started searching for a flame retardant with three key characteristics:

- Safe to use for farm operators and on the land where food would be produced;
- Could be applied through normal spray nozzles; and,
- Would have residual efficacy so that it could be applied weeks or months in advance of a fire actually occurring.

We were also interested in any soil nutrition benefits that might be gained from the use of phosphate-based retardants.

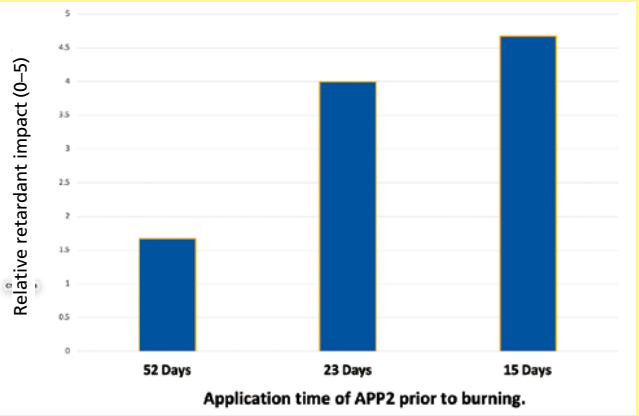
Ammonium Poly Phosphate Phase 2 (APP2) – a commercial flame retardant product – was tested as a fire suppressant in stubble paddocks in 2017.

In addition to fire mitigation, using APP2 to reduce the risk of paddock fires, or suppress an already burning fire, appears to offer other benefits including phosphorous inputs and the sequestration of long-term soil carbon.

APP2 and DAP both have very similar N:P ratios (N:P 18:20).

The APP2 fire retardant can reduce the intensity of fire across stubble and increase the amount of charred carbon residue.

FIGURE 1: Flame retardant effect of APP2 over time, SANTFA 2017 trials



The rate of APP2 required to mitigate fire in a surface broadcast spray is equivalent to a high rate of DAP fertiliser.

In 2017 a replicated trial was established on the northern Adelaide Plains to assess the nutrient benefit of phosphorous from APP2 applied to stubble that was subsequently burnt to a charred residue.

In this particular trial, the APP2 was applied to stubble, that was then burnt, before the paddock was sown to wheat.

APP2 has not been tested in the extreme conditions of a real wildfire but controlled burning experiments in our 2017 and 2018 trials showed that it can reduce the intensity of fire across stubble and increase the amount of charred carbon residue remaining on the soil surface after a stubble fire (see photo).

But the results showed that the price of APP2 – combined with the high application rates required to achieve meaningful fire risk reduction – makes it a high-cost fertiliser option. Although, other potential benefits were identified.

Unlike conventional phosphate fertilisers, the broadcast application of APP2 does help to mitigate fires, and in doing so, leaves a level of crop residue (soil cover) after a burn. This is good for the soil's health with the provision of binding sites and habitat for beneficial soil micro-organisms.

But for strategic and economic use in modern Australian grain farming systems, a flame retardant needs residual staying power to last through our long fire danger periods.

Adjuvant breakthrough for residual fire protection

SANTFA's first two years of flame retardant product screening and field trials showed that traditional flame retardants can work well if sprayed onto the stubble just before ignition or directly on the burning fire. The retardants had very limited residual effect .

Our trials showed that high-rate APP2 treatments applied prior to a burn could be effective as a flame retardant in the short-term. But as Figure 1 shows, they lost their fire retardant effect over time.

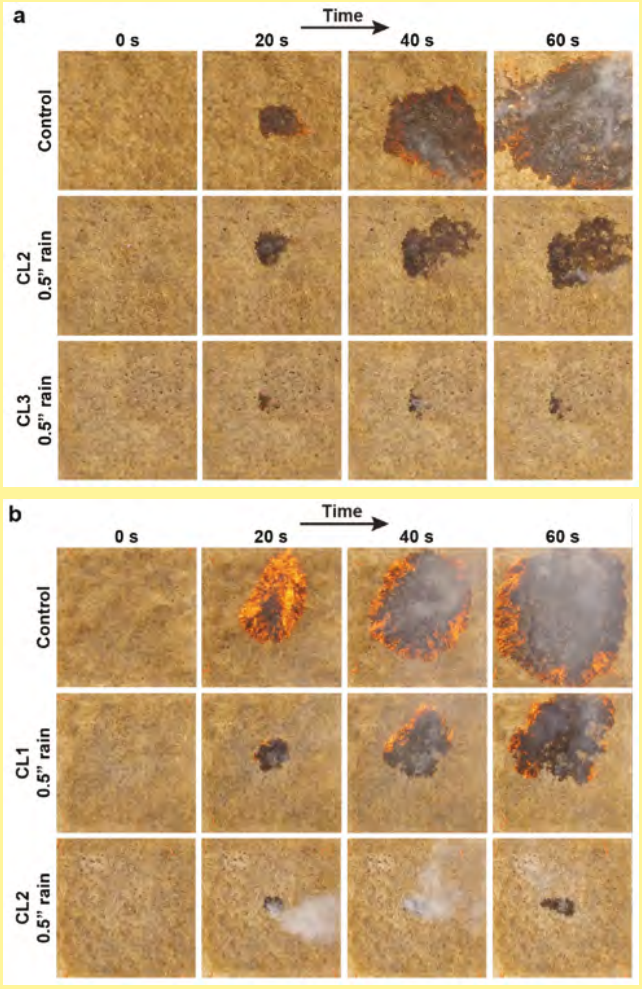
These preliminary results implied that, to be effective as on-farm fire inhibitors, flame retardants would need to be applied just prior to a fire or be applied to high-risk areas multiple times during the fire danger season.

But a breakthrough compound developed by a research team at the Supramolecular Biomaterials Laboratory of Stanford University in the US, led by Assistant Professor Eric Appel, appears to have the potential to increase the effective life of APP2 as a flame retardant in crop and stubble paddocks.

Eric and his team have developed an environmentally-benign viscoelastic 'hydrogel' carrier that improves APP2 coverage, rain-fastness and residual performance.

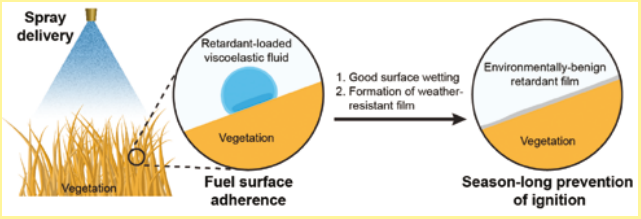
In field trials in California, application of APP2 – combined with the hydrogel formulation – to slashed and standing dry grass residue provided higher levels of protection for longer periods of time than application of AAP2 without the hydrogel. (Figures 2a and 2b).

FIGURES 2A AND 2B: Fire protection over time (in seconds) provided by the application of APP2 – with and without the hydrogel formulation at different rates (CL1, 2 & 3) – to slashed (a) and standing (b) dry grass



Images courtesy Dr Eric Appel.

FIGURE 3: Benefits of applying APP2 with the new hydrogel adjuvant



Images courtesy Dr Eric Appel.

Benefits of applying APP2 with the hydrogel adjuvant

- Maximises surface coverage by forming a film-like coating on the straw (fuel);
- Improves APP2 adherence to the straw, making it rain-fast for extended periods; and,
- Has the potential to provide season-long inhibition of ignition.

Coverage across the straw surface is important because the APP2 works like a mini molecular fire blanket that prevents oxygen getting to the surface of the straw in a fire (Figure 3). Any gap in the 'blanket' provides an opportunity for ignition.

The adherence and rain-fastness are also important because APP2 applied without the hydrogel is particularly vulnerable to washing off in rainfall and can flake off in hot and windy weather.

Wetters, oils and surfactants make a huge difference to the performance of most agri-chemicals and the combination of the new hydrogel and APP2 seems to follow that trend.

The key characteristics of the hydrogel suggest it could also improve the performance of other chemicals in other applications, such as spraying a foliar fungicide in winter. The hydrogel is also environmentally benign being formulated from odourless, non-toxic natural products and is used at low concentration (1.4 per cent of final volume).

Licencing and commercialisation

The hydrogel technology has been licenced by the Stanford University team and the hydrogel formulation of AAP2 is being commercialised by Ladera Tech as 'Fortify'.

According to Ladera Tech President and CEO Wes Bolsen, there is significant US interest in Fortify, which he describes as an aqueous formulation of APP2. In the US the product is being offered in 1000 litre shuttle packs such as those used for liquid fertilisers.

The new product is already being used in the US by a range of entities including utility companies, the military and the Californian Department of Forestry and Fire Protection. The product is used to pre-treat target areas with residual flame retardant as part of data-driven fire management plans for the protection of lives, assets and infrastructure.

Fortify will be distributed In Australia through AgriTrading Pty Ltd and SANTFA will trial the new formulation as soon as it arrives.

At present, Australia does not have an Australian or New Zealand standard for fire chemical effectiveness and in the absence of this, Australia has adopted the US Federal Qualified Products List (QPL). The QPL process for Fortify will be complete at the end of December and the product is expected to be listed in January 2020, making it ready for use in Australia.

In the context of a stubble-retention farming system it is not likely to be economical to apply Fortify at paddock scale across a farm unless the cost is less than the combined values of a range of potential benefits including biochar remaining after burning treated stubble, soil carbon sequestration, the nutrients from the AAP2 and reduction in insurance cost.

Given the current discussions in Australia about the future cost of fire insurance, the potential to use a flame retardant may be worth talking about with your insurance agent.

With or without a direct insurance benefit there may well be a role for the new product in reducing risk of fire losses by using it to establish fire-resistant areas around houses, hay sheds, machinery sheds, base stations, livestock enclosures and along driveways.

There would also appear to be merit in developing co-ordinated community or region-wide plans for the strategic annual use of residual flame retardants to, for example, treat the vegetation around a local oval that acts as the community's bushfire 'last resort.'

The cost of fighting fires and the destruction of lives and property from wild fire is now so huge that we must be proactive and use all the tools available.

But a flame retardant is not a cure-all and is only one tool in the toolbox. A good fire management plan will have multiple integrated components.

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SANTFA
SOUTH AUSTRALIAN NO-TILL FARMERS ASSOCIATION

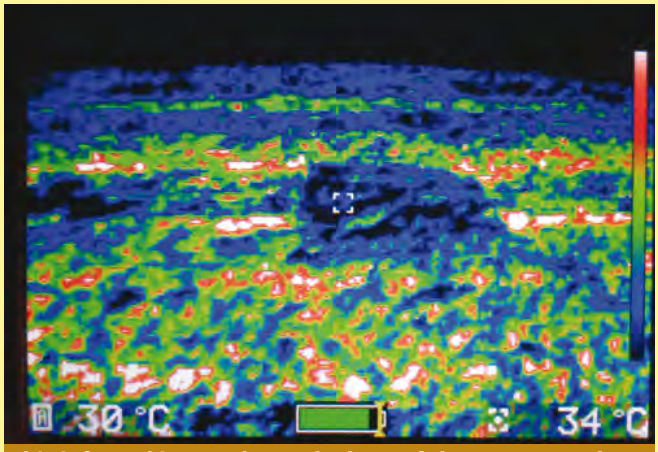
APPLICATION AND OPPORTUNITIES IN AUSTRALIA

The research breakthrough by the team at Stanford University has delivered an adjuvant that is a great partner for applying a flame retardant onto flammable biomass. The new technology offers a safe flame retardant that can be applied well in advance of a fire – and provide on-going residual protection for weeks and even months.

The standout benefits of this technology include the ability to strategically apply the retardant to prevent ignition and protect assets while freeing up vital resources during the actual fire.

Some key technical points

- Safety: We don't see any toxicity issues with the adjuvant and the active ingredient breaks down to a common fertiliser.
- Compliance: We anticipate regulatory approval for the commercial use of Fortify in Australia in the first few months of 2020. Fortify is expected to be approved by the USDA and placed on their qualified products list in January 2020.
- Cost Benefit: We know the active ingredient works proportionally to application rate and coverage. This means it's possible to quantify the investment required to achieve a specific outcome in a specific scenario – we just need to map out and quantify those scenarios.
- Carbon Sequestration: If used at sub-optimum rates, a back burn or fuel reduction activity can be converted from an emissions producing event into a carbon sequestration event. Given the huge scale of fuel load reduction being proposed to manage future fire risk, dictating the destination of the carbon (to the soil rather than the atmosphere) could be an important consideration.
- Local Formulation: The finished product is 80 per cent water, so shipping individual 1000 litre shuttles on a standard pallet from the US is a cost worth eliminating. Initially co-operating through a multi-industry group allows for cost reduction by having a bulk batch formulated under licence in Australia.



This infra red image shows the heat of the area treated with the fire retardant (blue) relative to the untreated areas (red) during the stubble burn.

To that end, LaderaTech has signed an agreement with South Australian agricultural supply company, Agritrading, to begin the rapid manufacturing and commercial sales of Fortify.

An Australian users association

As more information about pre-emptive fire control has started to flow in the past couple of years, and the technology developed at Stanford has entered the early commercialisation stage – a potential Australian users association has formed organically.

The idea is to share independent trial results for pre-emptive flame retardant across industries, develop application ideas and to get the critical mass required for successful commercial adoption and local formulation.

The new preemptive formulation is all but ready for commercialisation in Australia.