



## FACTSHEET – EFFECTS OF BUSHFIRES ON FRESH PRODUCE SAFETY

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This fact sheet describes the impact of bushfire on the safety and quality of fresh fruit and vegetables. It is divided into two sections: **part 1** addresses the effects of bushfires and **part 2** suggests practical actions.

### Background

In the summer of 2019-2020, Australia had one of the most extensive fire seasons on record. More than 19 million hectares were burnt, thousands of buildings were damaged, 34 people lost their lives and millions of native wildlife perished. In New Zealand in October 2020, at least 4,600 hectares of land in the



South Island was burnt by bushfire and 90 people were relocated.

With predicted changes in the climate, more and more people and businesses, including those in the fresh produce industry, will become exposed to the effects of bushfires. This fact sheet addresses questions about how bushfires can impact the safety and quality of fresh fruit and vegetables and what can be done in the event of a bushfire.

## **PART 1 - EFFECTS OF BUSHFIRES ON FRESH PRODUCE AND WORKERS**

### **Bushfires**

#### **When do bushfires occur?**

Bushfires are a common feature in Australian landscapes. In summer, much of southern Australia is hot and, with little rain, forests dry out and can become very flammable. In northern Australia, annual savanna fires are associated with the dry season. At other times of the year there may be planned fires, sometimes called 'burning off', to reduce fuel loads and the risk of bushfire.

#### **What happens when material is burnt during bushfire?**

Burning of combustible material – fuels – results in the release of smoke containing water vapour, gases, and fine particles ('particulate matter') and production of ash, char, and charcoal. The composition and quantity of smoke and debris produced during bushfire differs depending on the type of material being burnt, on the weather conditions and how the fire behaves.

Vegetation fuels that burn during bushfire generally consist of leaves, branches, bark and woody debris in forests and bushland. Grassfires occur in naturally grassy areas and paddocks. Unfortunately, orchards, vineyards, fields, and gardens can also become fuel if conditions are extremely hot, dry, and windy.

The characteristic white colour of smoke comes from water vapour released from fuels as they are heated while the grey or black colour of smoke comes from the fine particles created as fuels are combusted. Other complex gaseous products are also formed during combustion, many of which are air pollutants or greenhouse gases. Smouldering (flameless) fires produce more gases such as carbon monoxide and ammonia and fine particles than flaming combustion.

#### **Not all fires behave the same**

Fire behaviour describes the way that a fire burns, including how quickly it spreads, how much heat is produced and how much combustible material – fuel – is burnt.

### **Water**

#### **What can happen to irrigation water after bushfire?**

**The immediate impact** of a bushfire on sources of water for irrigation – streams, creeks, rivers, and dams – is generally limited. A fine layer of ash may be found floating on water surfaces but, in most cases, the amount will be small and pose little to no threat of microbial or chemical contamination. However, localised ash deposits may clog filters, valves, and trickle irrigation lines.



### How can I make sure that my water is safe?

To prevent contamination from dead animals in water sources, check immediately after bushfire for animals that have died during the fire. Make regular checks of dams and other water sources after bushfire as animals may continue to die from injuries sustained during the fire or from starvation or exposure if their habitat has been burnt. Be aware that bodies of smaller animals (e.g., mice and rats, small native animals) may pose just as much of a risk of microbial contamination as larger, more obvious animal carcasses (e.g., sheep, cows, kangaroos). Pathogenic bacteria associated with rotting carcasses can include *Campylobacter* spp., *Clostridium* spp., *Escherichia coli* O157:H7, *Listeria* spp., and *Salmonella* spp.

**In the weeks and months after bushfire**, water sources may be prone to increased sedimentation. The removal of vegetation and changes in soil structure can lead to ash and topsoil being washed into waterbodies during heavy rain. This is often referred to as a 'sediment slug'. The size of a sediment slug will depend on topography, timing and amount of rainfall, and the extent of burnt area around the waterbody. The microbial risk associated with sediment slugs is unknown but

may contain levels of enteric pathogens associated with animal faecal material. Consider the pre-fire use and condition of the catchment area surrounding a water body to gauge how the risk of run-off may have changed after bushfire. If in doubt, refrain from using the water until it can be tested.

The main types of pathogenic bacteria found in animal manure include *Campylobacter* spp., *E. coli* O157:H7, *Listeria monocytogenes*, *Salmonella* spp., and *Yersinia enterocolitica*. The primary manure-based protozoa include *Cryptosporidium parvum* and *Giardia lamblia*; other types of protozoa may be present but are less common. Viruses may also exist in animal manure. The ability of manure-based pathogens to contaminate water sources after bushfire will depend on their continued survival in the environment and opportunities for transport in the sediment slug.

More information about reducing food safety risks from animal manures is available from the FPSC fact sheet: <https://fpsc-anz.com/wp-content/uploads/2020/10/Factsheet-using-manurestogrowvegetables-201014.pdf>



### What is a post-fire algal bloom?

**Sediment slugs** entering a waterbody can increase the concentrations of nutrients and organic material in the water. This may lead to excessive growth of algae, commonly called an 'algal bloom'. Algal blooms can occur anytime during periods of dry, warm weather but may be more likely after bushfire with the addition of nutrients in runoff of surface sediments.

**Harmful toxins** can be released during algal blooms. The main species responsible for production of toxins are blue-green algae (*Nodularia spumigena*, *Microcystis aeruginosa* and *Anabaena circinalis*) and cyanobacteria (*Aphanizomenon ovalisporum* and *Cylindrospermopsis raciborskii*, but both species are not common in Australia). Fresh produce that has been in contact with water contaminated with toxins from an algal bloom may cause gastroenteritis if eaten; symptoms will include vomiting, diarrhoea, fever, and headaches.

Sediment slugs can also cloud the water, diminish light and reduce dissolved oxygen, leading to death of fish and aquatic invertebrates. Under such circumstances appropriate testing and remediation would be needed to improve water quality before use.

Good dam design that includes measures for erosion control will be adequate to prevent entry of post-fire sediments. The possibility of fire-derived sediment entering water is generally short-term as vegetation recovering after bushfire will help to stabilise soil surfaces and make good use of any additional nutrients.

### Can I use my rainwater tank after bushfire?

Ash settling on roof surfaces can be washed into the storage reservoir such as domestic water rainwater tanks. In this case, check and clean filters leading into the tank and, if possible, disconnect or close input pipes prior to the first rain after fire to allow ash to be washed away. Municipal water supplies will remain safe to use.

More information is available in the fact sheet on Reducing Food Safety Risks from Pre-harvest Water.

The FPSC Guidelines for Fresh Produce Food Safety also provides important information about requirements for potable water (e.g., washing of non-cooked foods).





## Soil

### What is the effect of bushfire on soil?

During bushfire, material on or near the soil surface, such as grass, horticultural residues, and organic matter, will burn. Much of the heat produced will be radiated into the air but some will also be conducted into the soil. The hotter the fire is (greater intensity), the more the soil will be heated.

### Is there a lasting impact of bushfire on soil that the fresh food industry needs to be aware of?

Heat produced during bushfire may act as a sterilising agent by killing microorganisms in the surface layers of soil. In most circumstances, soil will not be heated to depths of more than 5 cm. For beneficial soil fungi and bacteria, recolonisation of sterilised soil from nearby unheated soil can be rapid. Logically, recolonisation by harmful microorganisms can also be fast but there is no evidence available to suggest that bushfire promotes their proliferation.

### Why is soil hydrophobic after bushfire?

Bushfires may create waxy residues in the surface soil making it water repellent. This effect is most obvious in eucalypt forests and in sandy soils. Water repellence diminishes after rain and does not persist for more than a few years.

### What are the risks associated with fire retardants?

**Flame retardants** can impact vegetation directly through contact of chemicals with the foliage and stems (e.g., possible discolouration and chemical burn) and indirectly by the addition of nutrients to the soil. Flame retardants used in control of bushfire may be mildly irritating to humans but have no serious health effects. Regardless, produce exposed to bushfire firefighting chemicals should be discarded according to standard produce residue management practices.

Firefighting chemical used in household and industrial fires may contain toxins and **are quite different** from flame retardants used in controlling bushfires.

If bushfire firefighting chemicals such as flame retardants have been used on your property, the chance of chemical contamination of soil will be negligible. However, soil and water contamination due to fire-damaged infrastructure, such as chemical spills or leaks, will need to be assessed and remediated as required.

The steps required for **managing chemical spills** include controlling and containing the spill,



Credit: T. Bell

isolating the area concerned and, if required, contacting the appropriate authorities. Once the safety risk of the spill has been assessed, the spill should be cleaned up. Advice for managing and handling individual chemicals (i.e., toxicity, personal protection requirements) is included in the Material Data Safety Sheet (MSDS). The appropriate authorities (i.e., fire brigade, police, ambulance, and/or public health authority) must be notified if the chemical spill poses a threat to human safety or will harm the environment. If the spill has or is likely to enter drains or watercourses, contact appropriate water or river authorities to avoid cases of poisoning or contamination.

### **Fresh produce**

#### **What is the effect of ash on fresh produce?**

Even though your farm may not be directly affected by fire, ash and other fine debris may be carried several kilometres from their source and deposited on leaves and other plant surfaces. In fields and orchards, ash is removed naturally from plant surfaces by wind and rain and plant productivity is unaffected.

For produce that is ready for harvest, ash can be washed or brushed from surfaces. There is no evidence available that ash from bushfires is a source of microbial or chemical contamination. However, if ash cannot be removed easily from produce (e.g., berries, leafy greens) it will affect the appearance and flavour and should be discarded according to standard produce residue management practices.

If ash can be removed from produce surfaces without product deterioration, monitoring of cleaning equipment and washing tanks is recommended as residues can discolour water and clog filters. Ash and other fine debris also have the potential to alter pH of wash water or sanitation treatments, albeit very high loads would be required to do this. If applicable, allow particulate matter to settle before cleaning water reservoirs. Review your HACCP or food safety plan in relation to whether critical limits are being maintained at all times.

#### **Particulate matter (PM) is classified according to size**

PM<sub>10</sub> describes the particles in smoke with a diameter of 10 µm (micrometres) or less and PM<sub>2.5</sub> are particles with a diameter of 2.5 µm or less. For reference, a human hair is approximately 20-200 µm in diameter.

#### **What is the effect of smoke on horticultural crops?**

Much of the research describing the effects of smoke from bushfires on plant growth and functioning has investigated the role of smoke in promoting seed germination, stimulating flowering and the release of bulbs from dormancy. There is far less information available about the direct effects of smoke on plant physiology, and particularly not for fresh fruit and vegetables.

As an indication of the variety of effects that are possible, water extracts of smoke have been used to promote root initiation in mung bean and tomato. Similarly, seedling growth of okra, tomato and onion can be improved when supplied with smoke water or butanolide (a bioactive component in smoke).

Leaf characteristics, such as a thick lamina and protected stomata, can provide a means of protection against smoke. However, other leaf features such as hairs and rough surfaces may promote the adherence of ash but this should not have any lasting effect on plant growth.

#### **Are some fresh produce commodities impacted by smoke more than others?**

Generally, the impact of smoke on leaves is short-lived and leaf functioning returned to pre-exposure levels within 24-48 hours. For several horticultural species, leaf death due to smoke has been found to depend on species and variety and the type of fuel burnt (see Table 1).

Ethylene is used commercially to control the ripening of fresh produce. Minute quantities of ethylene (1 part per billion) can stimulate seed germination of some species and long-term exposure to the gas (e.g., over a growing season) can affect the production and timing of flowering for some crops. Fire can produce ethylene, a ripening and senescence related plant hormone that acts at very low levels. Ethylene generated by fire in the vicinity of an orchard or field could impact on produce by initiating ripening or shortening shelf life. The impact can be lessened by harvesting at the correct maturity and managing storage temperatures. Ripening and shelf life issues should be assessed through shelf life testing if there is any concern about ethylene exposure.

The concentration of smoke and gases produced during bushfires are higher near the fire front but are diluted as they move into the atmosphere.

**Table 1. Survival of leaves of several horticultural crops 1-week after exposure to smoke created by burning different types of fuel.**

✓ = 100% leaves still alive, O = up to 50% leaves died, X = 100% leaves dead.

Species tested	Source of smoke				
	<i>Eucalyptus saligna</i> leaves	Forest litter	<i>Pinus radiata</i> needles	Mixture of exotic and native grasses	Straw
Waratah	O	O	—	O	X
Orange var. Valencia	✓	✓	O	O	X
European Olive	X	X	X	X	X
Strawberry	X	X	X	X	X
Sunflower	O	O	X	O	X

In comparison, high air temperatures associated with summer conditions are potentially a greater accelerant of fruit ripening.

In contrast, exposure of grape berries to smoke during the growing and ripening period is far more detrimental and can cause smoke-taint of wine distinguished by unpalatable smoky aromas and flavours. In this situation, volatile compounds in smoke are absorbed through the skin of the berry and can be taken up by stomata in the leaves and metabolised to form phenolic glycosides. This effect has yet to be recorded for other types of produce. Smoke taint of fresh produce is unlikely as it has far less post-harvest processing compared to wine production. However, if unsure, taste products for smoke taint before shipping to prevent unnecessary customer complaints.

### Human health and safety

#### **My business is not in danger of being burnt but what other effect may there be on my staff?**

Bushfires can produce large quantities of smoke that can disperse over long distances. As a result, smoke may affect communities not directly threatened by fire. Smoke from bushfires can have adverse effects on the respiratory and cardiovascular system making exposure to smoke an important consideration for the safety of workers.

Large sized particles that are visible to the human eye are generally too large to be breathed deeply into the lungs. However, these particles can cause irritation to the nose, eyes, throat, and lungs. For healthy adults, the effects of exposure to smoke for a short period of time will clear relatively quickly after smoke disperses.

Other consequences that bushfires can create such as fatigue due to stress and heat exhaustion, should all be dealt with appropriately. Maintain high levels of hygiene and consider ways to reduce ash and smoke incursion into growing, cleaning, packing or storage facilities. Businesses that have suffered power losses should be aware of food safety risks and reduced quality of fresh produce associated with spoilage of products.

#### **What signs indicate human exposure to bushfire smoke?**

Finer particles and gases in the smoke are the most dangerous to human health. Fine particles and gases can accumulate in the eyes, nose and lungs and cause discomfort including burning or itchy eyes, runny nose, sore throat, headache, and coughing. Children, the elderly, and people with pre-existing conditions such as heart or lung disease, including asthma, are more sensitive to the effects of inhaling fine particles. People with heart disease might experience chest pain, palpitations, and shortness of breath or fatigue. Those with lung disease may not be able to breathe easily and may develop symptoms such as wheezing, coughing, phlegm, and chest discomfort. If any of these symptoms occur, seek medical advice immediately.

#### **Do masks prevent smoke inhalation?**

Certain face masks can help filter out fine particles found in smoke. These are rated as 'P1' or 'P2' and are available at most hardware stores. Paper dust masks, handkerchiefs and bandannas are not suitable as they do not filter out fine ash and are generally not very useful in protecting airways. It is important to note that masks are far less effective if there is a poor seal around the face and mouth, for example, for people with beards.



## **PART 2 – PRACTICAL ACTIONS THAT PRODUCE BUSINESSES CAN TAKE**

### **Leading up to and during summer**

- Know the bushfire risk for the area where fresh produce is grown or packed and make an appropriate emergency plan.
- Keep employees and visitors informed about bushfire risk and what to do in an emergency.
- Stay informed – when does fire season start? How can you find out about local bushfire conditions? Who should you contact if you see smoke? Do you know what an alert level is?
- Protect properties by cleaning gutters regularly, keeping lawns and gardens well maintained, removing leaves and twigs that accumulate, and pruning trees and shrubs close to buildings.
- Become involved in the local community, get to know your neighbours.

- Identify important business documents and infrastructure that should be retrieved should any premises need to be vacated. Critical documents be stored electronically in case they cannot be retrieved.
- Consider creating a business continuity plan detailing actions to be taken in the event of a bushfire and how to recover.

### **Safety and awareness during bushfire**

- Follow safety advice from local authorities for early and safe evacuation.
- Keep informed about fire, smoke and weather conditions in your local area.
- If staff must work outdoors in smoky conditions, they should wear suitable face masks (P1 or P2).
- If staff are working indoors with smoky conditions outside close as many doors and windows as practical, reduce physical activity and refrain from smoking. If available, use an air conditioner with a good air filtration system.





- Staff with a pre-existing heart or lung condition should remain indoors or relocate to an air-conditioned facility with adequate particle filtration such as a commercial building or shopping mall. Seek medical advice if health condition worsens.

### Post-fire checks and maintenance

For safe, clean water after a bushfire, consider the following points:

- After rain, ash will wash off hard catchment surfaces such as roofs into water reservoirs. Check the quality of water in storage tanks before use in dump tanks or spray rinses.
- If water looks cloudy or is discoloured or tastes and smells unusual, then it is likely to be contaminated. If in doubt, assume that it is unfit for use until it can be tested (chemical and microbiological).
- Post-fire, ash and soil sediment may be washed into creeks and dams. Check water quality (chemical and microbiological) before using for irrigation. Water from deep bores should be unaffected.
- Create banks around waterbodies to prevent sediment run-off post-fire.

For safe, clean fresh produce, consider the following points:

- Check fresh produce for ash deposits, clean and sanitise if required. If damaged, dispose of waste according to standard residue management practices.
- If fresh produce is washed, be diligent with checking wash water and sanitiser facilities as ash may discolour water and introduce more fine particles than expected.
- Maintain high standards of personal hygiene including regular handwashing and cleaning of clothing. In smoky conditions, fine particles can enter buildings and deposit on surfaces. While the risk of chemical or microbial contamination from smoke is small, the quality of fresh produce may be affected.
- Check that power supplies to food storage facilities have not been interrupted.

### Useful websites

#### Preparing for bushfire

<https://www.rfs.nsw.gov.au/plan-and-prepare>

<https://www.cfa.vic.gov.au/plan-prepare>

<https://www.cfs.sa.gov.au/prepare-for-a-fire/surviving-a-bushfire/>

<https://www.redcross.org.au/get-help/emergencies/looking-after-yourself/how-to-prepare-for-a-bushfire>

#### Water

<https://agriculture.vic.gov.au/farm-management/water/managing-dams/minimising-algal-growth-in-farm-dams>

<https://www.waterquality.gov.au/issues/bushfires>

<https://www1.health.gov.au/internet/publications/publishing.nsf/Content/ohp-enhealth-raintank-cnt-l-ohp-enhealth-raintank-cnt-l-4-ohp-enhealth-raintank-cnt-l-4.1>

<https://www.agric.wa.gov.au/small-landholders-western-australia/toxic-algal-blooms>

<https://www.health.vic.gov.au/water/health-effects-of-blue-green-algae>

[https://www.dpi.nsw.gov.au/\\_\\_data/assets/pdf\\_file/0008/186380/chemical-spills.pdf](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/186380/chemical-spills.pdf)

#### Effects of bushfire on fresh produce

<https://today.oregonstate.edu/news/take-precautions-when-wildfire-ash-falls-fruits-and-vegetables>

<https://www.redding.com/story/life/home-garden/2020/09/25/fruits-veggies-exposed-wildfire-smoke-safe-eat/5859875002/>

<https://cesonoma.ucanr.edu/files/285944.pdf>

<https://montegattafarm.com/garden/how-does-wildfire-smoke-affect-garden-crops/>

<https://www.vegetableclimate.com/research-and-reports/extremes-and-risk/bushfires-climate-change-and-vegetable-production/>

<https://www.health.vic.gov.au/environmental-health/fire-retardants-and-health>

The FPSC is providing these fact sheets to translate relevant published research for the Australia and New Zealand fresh produce industries.

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