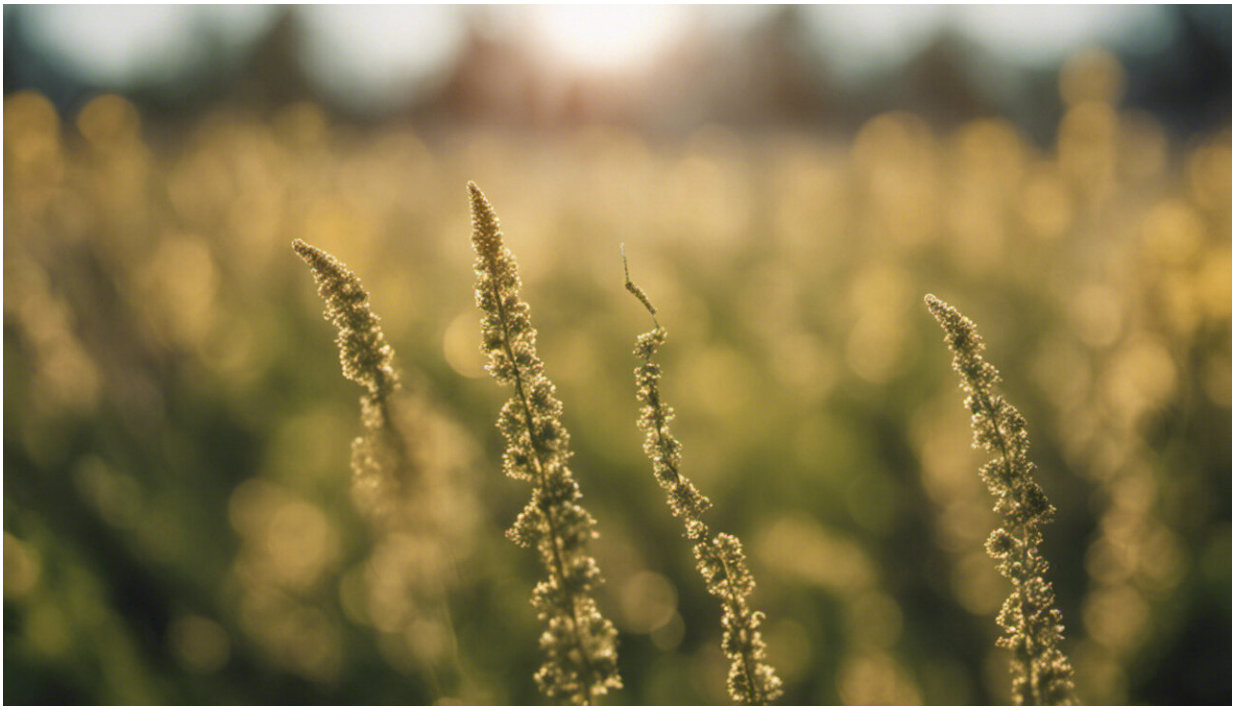
Why don't plants get sunburn?

July 12 2016, by Nigel Paul



Credit: AI-generated image (disclaimer)

The one fact about plants that most people probably remember from school is that they use sunlight to make their own food. That process, photosynthesis, means that plants are dependent on sunlight. But as anyone who's forgotten to put suncream on during their day at the beach knows, the sun can also be damaging. So how do plants absorb the light they need while avoiding damage from the sun's ultraviolet (UV) rays? The short answer is by making their own sunscreen. And new research is

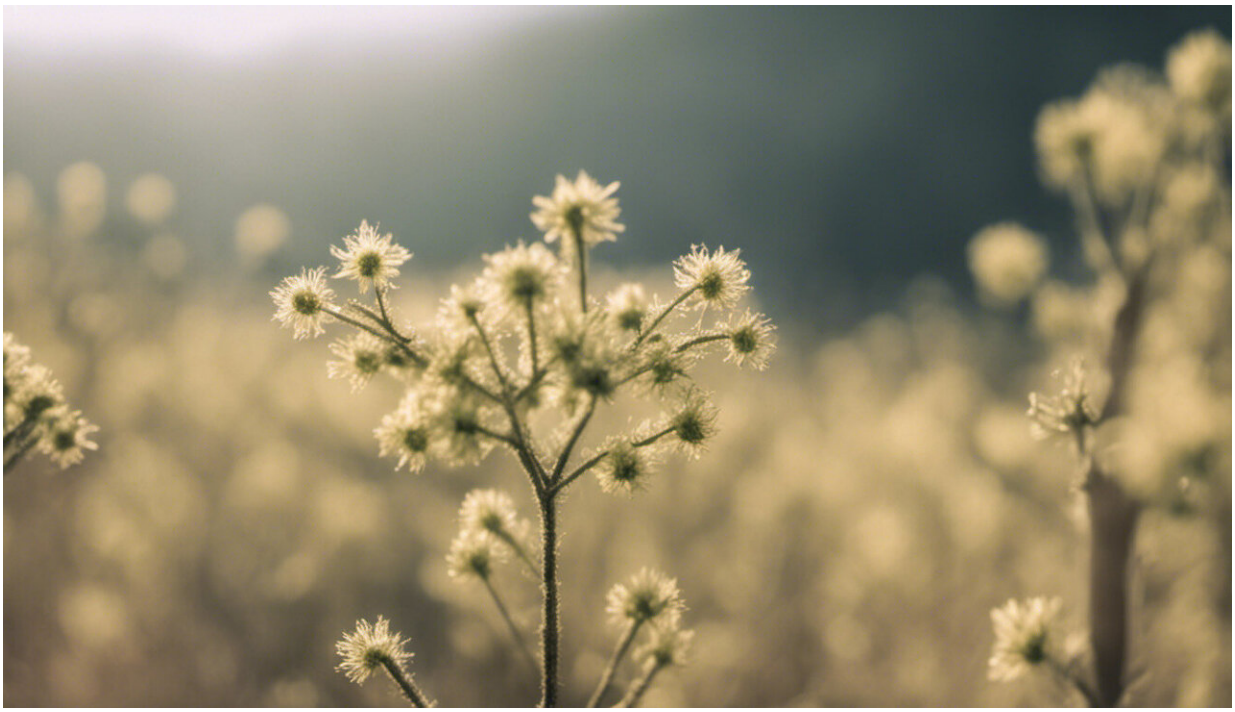
helping us to understand exactly how that process works.

We know too much UV can be damaging to human health. In the short-term, excess UV – especially the shortest wavelengths in sunlight, known as UVB – causes sunburn. Repeated skin damage due to UVB exposure over decades can lead to an increased risk of skin cancers. Of course, different people can tolerate different amounts of UV. People with deeply pigmented (darker) skin are well protected all the time, whether they are out in the sun or not. Others need some exposure to sun to induce protective skin pigments by developing a sun tan. And some people barely tan at all, leaving them highly vulnerable to sunburn and other UV damage.

Of course we can all also choose to avoid the sun, wear a hat or use suncream. But what about plants? They have to stay in the sun. Is there a plant equivalent to sunburn or to the protective pigments we have in our skin?

Plant scientists really began to think about those questions when depletion of stratospheric ozone – the hole in the ozone layer – threatened to allow much more UVB to reach the Earth's surface. Research back in the 1980s and 1990s showed that the high levels of UVB that would result from ozone depletion could directly damage photosynthesis. Other effects of high UV can also reduce growth and crop yields.

But the same body of research showed that plants are well-protected from the worse effects of the UVB levels we experience now. This protection comes from a suite of natural plant chemicals, mostly phenolics. These phenolic compounds act as natural sunscreens, strongly absorbing UV but not the wavelengths needed for photosynthesis.



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Just as with human skin pigments, the amount of these natural sunscreens varies between plants. Some plants, typically those that come from the tropics or from high-altitude mountains, have high levels of protection all the time. Others only produce sunscreens when exposed to higher levels of UVB, equivalent to tanning in humans.

That leads to another question. If plants produce their sunscreens based on their exposure to UV, how do they detect that exposure? And how do plants detect UVB?

It has only been in the last decade or so that plant scientists have shown that plants detect UVB very specifically using a protein known as UVR8 (short for UV resistance locus 8). Plants that lack UVR8 cannot induce protective sunscreens and are severely damaged by the UV present in

summer sunlight.

Researchers are still actively investigating the fundamental mechanisms by which UVR8 controls plant response to UVB. We've known for some time that UVR8 absorbs UVB, causing changes that ultimately allow the UVR8 protein to accumulate in the nuclei of the plant's cells. This is a necessary step in the chain of responses that allow plants to protect themselves against UVB damage.

New research from the University of Geneva showed that UVB responses depend on interactions between UVR8 and another protein called COP1 (constitutively photomorphogenic 1). This protein interacts with other various molecules (HY5, SPA and RUP) in a plant's cells to send a signal controlling the build up of sunscreen phenolics in response to UVB.

UVR8 was first detected in Arabidopsis thaliana. Credit: Wikimedia Commons, CC BY-SA

More sustainable crops

This might seem like an alphabet soup of abbreviations but the signalling system it represents affects us all through its role in the plants produced by farms as crops. We now know that plants use UVB as a signal to change their chemistry in ways that affects much more than just their UV protection.

UV exposure produces biochemical changes that can increase resistance to pest and disease attack. The UVB in sunlight improves the colour, taste and scent of fruits, vegetables and flowers. UVB exposure also increases levels of plant chemicals that are thought to be valuable in the human diet.

The new research adds to our increasing understanding that the UVB in sunlight shouldn't be seen just in terms of damage. So long as we keep protecting the ozone layer, the effects of UVB will be just one part of plants' normal responses to their environment. And the more we understand these responses, the more we can use that knowledge to produce more sustainable crops, improving their quality and reducing the use of pesticides.

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