Using gene editing to control forest fires? It could be a reality if anti-biotechnology activists don't block it

The American west has experienced devastating wildfires in recent years; while the number of fires has decreased a little over the past 10 years, the amount of acreage burned has bloomed, threatening residents, businesses, transportation and even some cities.

One major source of fuel for these fires is dead trees. Particularly dead pine trees. What's killing these trees? An insect called *Dendroctonus ponderosae*, commonly referred to as the mountain pine (or pine bark) beetle (there are many other pine beetles, too). It's attracted to white mountain pines that live at high altitudes, as well as lodgepole and Ponderosa pines, which live just about everywhere. And they've killed billions of pine trees by chewing away at the cambium underneath the tree's bark. But they don't kill them all, and therein lies some hope.

The bugs start their damage when adult females lay their eggs just under a pine tree's bark. At the same time, she also spreads fungi, which chemically turns tree tissue into food for larval beetles. This ultimately kills the tree, as the youngsters feed on both fungi and tree. Healthy trees can use a number of chemicals to repel adult beetles, but drought conditions and excessive heat can impair the pine trees' ability to wield these weapons. And bark beetles have always searched for weaker trees.

A number of forestry experts and scientists have been searching for ways to reduce the damage created by the beetle. The fewer dead pine trees that exist, the less severe future wildfires will be. One area scientists are turning to is genetics, especially the modification of pine trees to resist the pine bark beetle.

This specific area of genetic research, in its infancy, could be threatened by environmental activism, if past activities are an indication. Groups like The Campaign to Stop GE Trees have long opposed genetic modification—including long-term field testing, a necessary step for long-lived organisms like trees—ever since the first genetically modified tree was proposed in the late 1980s:

> Trees such as eucalyptus, American chestnut, poplar and pine are being genetically engineered for traits including faster growth, insect and disease resistance, and altered wood composition. If released commercially, these GE trees risk contaminating native forests, damaging ecosystems and harming communities due to the following:
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> Trees have a very long life-cycle. They can live for decades to centuries, so the risks they pose to forests and communities are impossible to assess over the long term. Because these risks are both potentially very dangerous and unknowable, GE trees must be prohibited.

While other trees—poplars, willows, eucalyptus and even the American Chestnut—have genetically

modified versions, the pine trees targeted by these beetles do not. But researchers at the University of British Columbia and the University of Montana have started identifying genetic traits that resist the actions of pine beetles. And if those traits that offer resistance can be traced back to specific genes as they have for the American Chestnut and others, then that gene could be transferred to other trees, generating more beetle resistance.

Or, the resistant trees could just be bred and encouraged to grow.

Diana Six, chair of Ecosystem and Conservation Sciences at the University of Montana, in July published a paper in *Frontiers in Plant Science* showing that whitebark and lodgepole pines that survived beetle infestations (less than 10 percent of all the trees affected) were genetically distinct from trees in their general population:

> Our results indicate that during outbreaks, beetle choice may result in strong selection for trees with greater resistance to attack. Our findings suggest that survivorship is genetically based and, thus, heritable.
> Retaining survivors after outbreaks to act as primary seed sources could act to promote adaptation.

Here is a TEDx Talk video by Six on the problem with bark beetles and forest devastation:

Six's study follows a 2008 British Columbia report that also found genetic traits among trees that survived bark beetle infestations. In this case, UBC researchers Joerg Bohlmann looked at the genetic make up of oleoresin in spruce trees, showing that a complex genetic network could blend certain chemicals that enabled the trees to survive changes in climate and precipitation.

In both of these cases, while genetic traits (including clearly inherited ones) suggest the genetic modification could produce a resistant tree, neither have specifically identified the genes that could be modified. That's important for traditional GM products. And a review by Swedish University of Agricultural Sciences lamented the dearth of research, especially field studies, that could point to how GM trees could function in the wild.

There are two types of traits with trees to pursue: transgenic (or now, cisgenic) traits like Bt genes could be inserted, or endogenous trait enhancement, in which genes are selected that already exist and could produce chemical resistance to pine bark beetles.

But you'll need to find the gene first. And then you'll need to experiment on the gene. Something that anti-GM activists so far don't want.

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