

---

FEATURE 14 February 2018

# Dirty talk: How pollution is snuffing out plants' scent messages

Plants use a fragrant language but filthy air is messing with their communication lines, which might explain why insects are in decline and roses are losing their scent



Goncalo Viana

By **Marta Zaraska**

IN THE classic post-apocalyptic novel *The Day of the Triffids*, giant carnivorous plants terrorise humanity. Triffids can walk and are equipped with venomous stingers, but their real power lies in their ability to communicate and so plot against us.

It sounds far-fetched, but since John Wyndham's book was published in 1951, one aspect of this fiction has proved to be science fact: plants do talk to one another. If you stroll through a forest and take a deep breath, you can smell the "words" – complex volatile chemicals such as beta-pinene, which smells fresh and piney. Plants produce thousands of these, combining them to create "sentences".

However, this fragrant language is under threat. Air pollution is disrupting floral scents, turning their messages into gibberish. Not only is this having an impact on plants' abilities to survive, it is also bad news for pollinating insects – and for us, because it affects everything from crop yields to the smell of our favourite flowers. Luckily, there is a way we can help our botanical friends fight back.

It has long been known that insects such as pollinators and pests can distinguish between plants by the unique bouquet of chemicals they release. What's new is the idea that plants use their emissions to talk among themselves. "Plants release volatile chemicals into the atmosphere – these can be viewed as a language in the sense that a plant releasing the chemicals can be viewed as 'speaking' and the plant receiving them as 'listening' and then responding," says chemical ecologist James Blande at the University of Eastern Finland.

Many plants warn one another of an impending pest attack. When a tomato plant is infested with cutworms, for example, it releases a cocktail of volatile chemicals into the air that is picked up by others nearby. On "hearing" the warning, these tomato plants respond by producing glycoside, which triggers the release of a poison to ward off the hungry caterpillars. Other plants use a similar approach to summon help from friendly insects. When aphids infest soybeans, for instance, the plants sound a chemical "burglar alarm" that brings ladybirds to the rescue.

Now we are discovering that air pollution can disrupt these communications. In one study, Blande and his colleagues put

individual bumblebees into a chamber containing paper flowers resembling those of black mustard. When the scientists injected the scent of real black mustard flowers that grew in either a clean or polluted atmosphere the bumblebees' reactions were unequivocal: they were immediately attracted to the unpolluted scent, while that from polluted air left them buzzing around aimlessly.

What's going on? In the past few years, ozone and nitrogen oxides have emerged as the main gibberish-inducing culprits. These ultimately result from vehicle and power plant emissions, with diesel exhaust a particular problem. Both ozone and nitrogen oxides react with the volatile chemicals released by plants. This changes the smell of their bouquet by degrading some compounds in the mix more readily than others. When monoterpene limonene, a common "word" of oranges, is mixed with ozone, for example, it degrades into as many as 1200 different compounds.

Such degradation can happen surprisingly fast. Ecologist Robbie Girling at the University of Reading, UK, and his colleagues exposed eight common compounds produced by flowers to diesel exhaust. "What we weren't expecting was the speed with which these reactions seem to be occurring," he says. "Within a minute, which is the shortest time period our method could resolve, we couldn't see anything of one of the compounds. It was instantaneously undetectable." (See "When plants talk dirty")

It's not just the clarity of plant language that gets disrupted, the "loudness" is affected, too. The scent of plants simply can't travel as far in polluted air as in pristine conditions. To find out how much things have changed since pre-industrial times, Jose Fuentes at the University of Virginia and his colleagues made a computer model that included historic air pollution levels. It revealed that scents produced by flowers that could once be picked up kilometres away now travel as little as 200 metres.

## **"Scents that could once be picked up kilometres away now travel only metres"**

Even between clean and dirty environments today, a similar reduction in signal can be seen. Take lima beans. When one plant is attacked by spider mites, it emits chemical signals that prompt others nearby to

produce more sugary nectar. This, in turn, attracts predatory mites, which eat the attackers. If the atmosphere is clean, Blande found, the beans easily communicate with neighbours growing 70 centimetres away. But if ozone concentrations top 80 parts per billion (ppb), their warning cries can't be heard more than 20 centimetres away.



Goncalo Viana

This 80 ppb of ozone pollution seems to often be the level above which problems start. That's bad news because in urban areas concentrations of ozone often exceed 100 ppb, and sometimes even 200 ppb. It is less clear when nitrogen oxide levels become a problem, but in the UK, nitrogen dioxide from diesel exhaust is undoubtedly doing damage. Its impacts on human health mean there are legal limits for emissions, but these are regularly breached. For example, hourly levels of nitrogen dioxide shouldn't exceed 200 micrograms per cubic metre more than 18 times in one year, yet in parts of London this happened in just the first few days of 2017.

Urban gardeners may notice the effects. "These pollutants definitely affect the smells from plants," says Blande. Nitrogen oxides can reduce the time for which some floral scents linger in the air from 18 hours to a mere 5 minutes. Scented flowers such as roses don't have the same strong aroma in cities that they have in rural locations, says

Blande. You have to get really close to smell them, and even then you are unlikely to experience the full aroma because compounds such as the clove-like beta-caryophyllene are quickly destroyed by pollutants.

It's not just our noses and poetic natures that suffer when the scent of flowers is disrupted. "I don't think it would be too big a jump to suggest that air pollution could also be a factor in reducing the numbers of flying insects," says Girling. Insect numbers have been falling globally, a situation that came to prominence in 2017 when it was revealed that insects in German nature reserves had declined by an alarming 75 per cent in just 27 years.

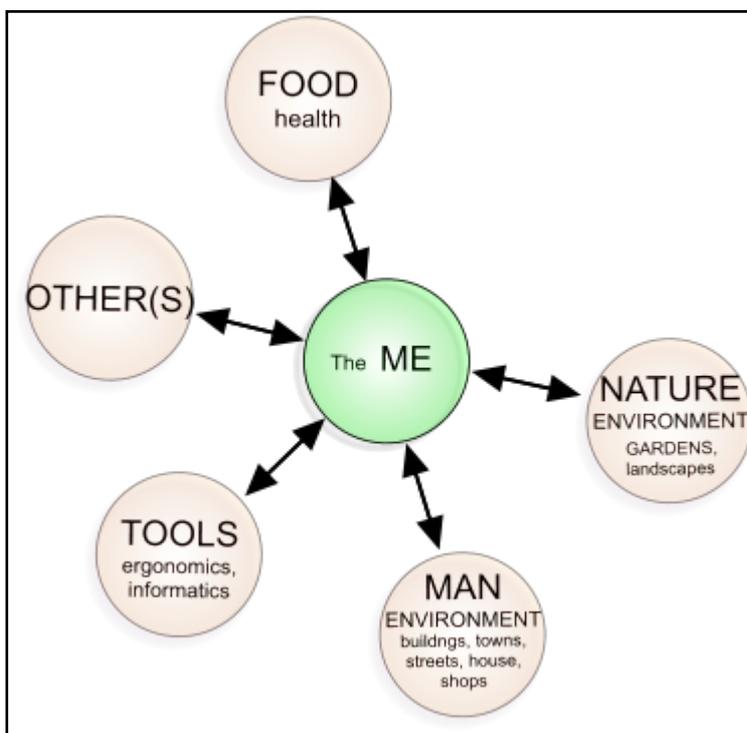
Miscommunication between flowers and insects could be particularly significant for pollinators such as bees. Although no one has yet measured the overall impact this has had on bee numbers, Girling has found that the common volatile myrcene is particularly easily damaged by diesel exhaust – and this can lead honeybees astray. His team found if they removed myrcene from flowery scents, only 37 per cent of bees still recognised them.

As the language of plants becomes increasingly garbled, the impact on the survival of pollinators and plants themselves threatens to destabilise whole ecosystems, with serious implications for the natural world and commercial crops. Efforts are under way to reduce pollutants such as diesel exhaust but progress is slow. The good news is that there is a simple and immediate step we can take to help plants communicate: grow more of them to mop up the pollutants. Some plants are better at this than others, but research suggests reforestation is a particularly good option because trees have a large surface area to absorb ozone and nitrogen dioxide from the atmosphere.

Urban planners are already moving in the right direction. Many cities now have vertical gardens and living walls. Near London's Victoria train station, for example, a 20-metre-high wall contains more than 10,000 plants. Even trees are being planted on the sides of buildings. In 2014, the first forest skyscraper went up in Milan, boasting 800 trees and almost 20,000 other plants. In China, the Nanjing Green Towers, currently under construction, will have 1100 trees along with thousands of other plants, and a whole forest city is planned in Liuzhou.

Such urban forests do, of course, have their communications undermined by pollution, but they also serve to reduce its impact on other plants. What's more, with more plants closer together they don't have to shout as loudly to be heard. It seems like a no-brainer. Nevertheless, Fuentes injects a note of caution. He points out that some plants produce lots of organic molecules that are precursors of ozone, so can make matters worse when mixed with dirty city air. "Oaks, poplar trees – those are no-nos," he says.

And what about rural areas? Although such places are often cleaner, pollutants can have a disproportionate effect here because of their impact on commercially important plants. The solution, says Fuentes, is to plant more flowers around crop fields – in particular, he recommends petunias. These won't just clean up the pollutants that disrupt plant communication, but will also attract pollinators. If the flowers smell sweet, that's even better for our human noses. It's a win, win, win solution.



## When plants talk dirty

Plants produce volatile compounds to communicate. In different combinations, these can tell other plants to “prepare for attack”, or they can attract or repel insects. However, air pollution is disrupting these lines of communication by breaking down many of these chemicals (see main story), including some of the most common ones that give plants their distinctive aromas.

### Myrcene

A peppery, woody scent with a touch of carrot, myrcene is produced by many plants including rose and orchid flowers, and tobacco and tomato leaves. It degrades readily in the presence of diesel exhaust, which can confuse pollinators such as bees.

### Monoterpene limonene

A citrusy scent produced by oranges, lemons and cannabis, this degrades into as many as 1200 different compounds when mixed with ozone.

### Beta-caryophyllene

A clove-like scent produced by roses and lavender, this is readily destroyed by pollution, which may explain why flowers in urban gardens are lacking in aroma.

### Beta-ocimene

With its tropical citrusy odour, this is more quickly broken down by pollution than any other scent tested. Mixed with diesel exhaust it becomes undetectable in less than a minute.

### Benzaldehyde

This almondy scent reacts with ozone slowly compared with other volatile compounds produced by plants.

*This article appeared in print under the headline “Silence of the plants”*

---

**Marta Zaraska** is a writer based in France