Virus-infested fungus could help cut chemical pesticides

15 February 2019, by Ioly Kotta-Loizou And Robert Coutts

Ant infected and killed by entomopathogenic fungus. Credit: Protasov AN/Shutterstock

The evidence against chemical pesticides is mounting. An estimated 7m people are at risk from exposure to pesticides globally, while a million a year suffer or die from pesticide associated diseases. And that says nothing of the damage they are thought to be doing to other wildlife. Yet when humanity needs to produce approximately two billion tons of crops every year to feed itself and the population is still increasing, it's difficult to see how we can grow the necessary food without pesticides.

But there is another way to kill insects that destroy crops without hurting humans or other wildlife. It involves harnessing more natural means in the form of microorganisms. This kind of biological control has typically not been found to be as successful as chemical approaches. However, our recent research suggests that teaming up insect-killing fungi with "friendly" viruses could help develop next-generation insecticides that are both environmentally friendly and highly efficient.

Fungal-based insecticides contain insect-killing fungi. When they come into contact with an insect, they use pressure and enzymes to force their way into its body. Then the fungus uses the nutrients of the insect to grow from the inside, eventually overwhelming and killing its host. The problem with current mircoorganism-based insecticides is that they aren't always as efficient or reliable as their chemical counterparts, depending on conditions such as temperature, humidity and UV radiation.

As a result, they are a lot less popular with farmers, who tend to use them largely in controlled greenhouses. Only 40kg of fungal-based insecticides were used in the UK in 2015, compared to over 600 tons of chemicals.

We recently discovered that infecting one of the most popular insect-killing fungi, *Beauveria bassiana*, with a virus made it grow faster and more likely to cause disease in insects. This suggests that viruses, far from always harming the organisms they infect, could be used to improve fungal-based insecticides.

Beauveria bassiana killing a spider. Credit: Michel Wallace, CC BY-SA

But before we can start using virus-infected fungi on crops, we need to understand how these viruses spread from one organism to another and whether they mutate regularly in order to ensure the safety of the potential applications. For instance, we would not want the viruses to spread to other fungi and disturb the balance of an ecosystem, or to mutate into viruses that are not beneficial or are harmful.

We recently performed an extensive investigation on a native population of viruses infecting Spanish variants of *B. bassiana*. The variants were collected from soil, plants or insects to help us understand how the viruses behave in the wild. Our study revealed a complex population of viruses from three different species, which could infect the fungi separately or together. Individual viruses from the same species were very similar but not identical. This suggests they form quasispecies, much like important viruses that cause human diseases such as the flu and HIV.

This observation helps us understand if mutations in the viral genome are acceptable or not. We found that the virus species responsible for increasing the fungi's growth and ability to cause disease was less likely to tolerate a mutation than the other two species. This is encouraging because it makes the virus more reliable and safe as a way to improve the fungal insecticide.

Field tests

Our next step will be to add the virus to a fungal-based insecticide. Then we can test if the fungal-based insecticide is improved. We may need to make changes to the virus or the fungal-based insecticide to ensure the best possible efficiency. We also need to confirm that the fungal-based insecticide with the virus will not kill beneficial insects, such as bees.

It may not be possible to entirely replace chemical insecticides with fungal-based ones because the growth of fungi depends so much on environmental conditions. In the field, fungal-based insecticides can be combined with chemical insecticides (integrative pest management). Similar approaches are known to reduce chemical use by an average of 75% and increase yields by an average of 40%. This makes fungal-based insecticides a promising way to reduce chemical use and further research will help expand their use in the future.

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