

### Overview

We want to ensure that you have the knowledge and tools to leverage the full potential of CIVITAS Fungicide. This technical bulletin outlines the increasingly prevalent issue of resistance with traditional chemical fungicides. We want to ensure that golf course superintendents understand the root of the issue and how to maximize the effectiveness of your integrated pest management system for optimal turf quality results.

### What is Resistance?

Resistance to fungicides can occur when the same fungicide is repeatedly applied to control a particular type of fungus. Most traditional systemic chemical fungicides have a distinct single point mode of action, where the fungicide acts on a specific protein or structure. This can be a highly effective method, but also leaves those fungicides vulnerable to the onset of resistance. On a molecular level, the single point of action means there is only one area of vulnerability that needs to be modified at the genetic level for the disease to become resistant.

The strain of disease that has this mutation can then survive future fungicide applications and flourish. This is the case because there is no longer any competition from non-resistant fungus for nutrients in the host. It then passes on its resistance to future generations to infect the turf again. The new generations of the resistant fungus cannot be controlled with that fungicide chemistry, and sometimes cannot be controlled with similar chemicals from the same fungicide family. This is due to the fact that fungicides within the same chemical family generally have similar modes of action and the same target site.

### Managing Resistance – The IPM Program

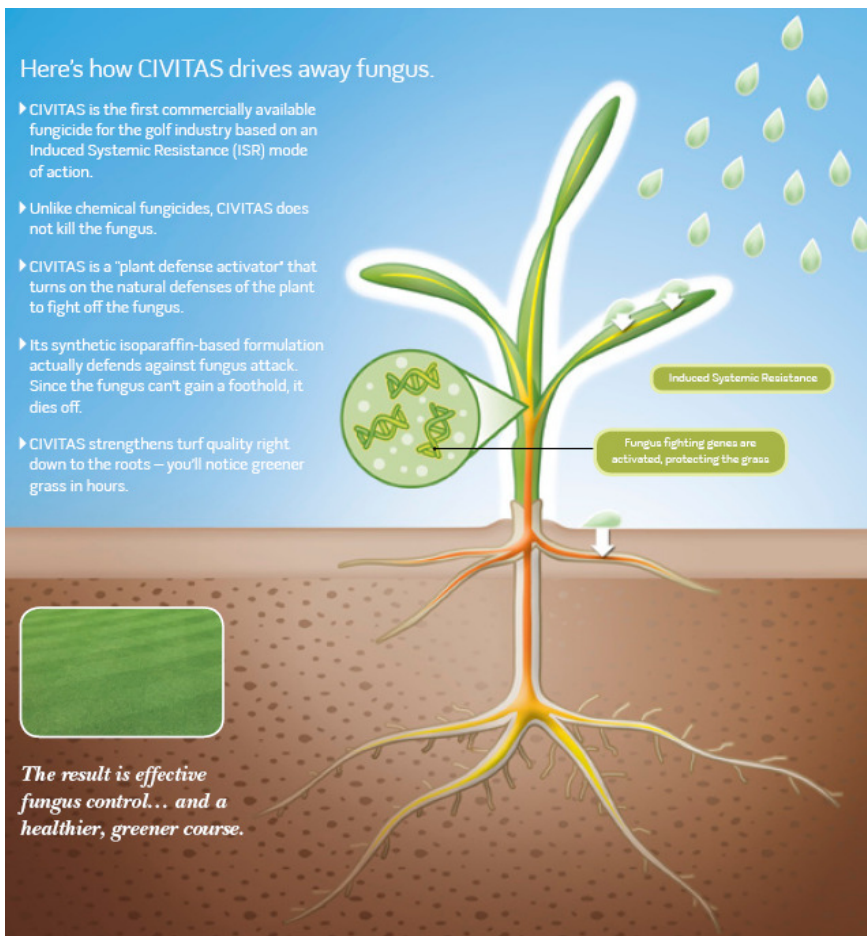
One method to combat the onset of resistance has been the introduction of the Integrated Pest Management (IPM) program. The idea behind the program is to responsibly use a selection of fungicides, from different chemical groups, in a rotation to prevent a build up of resistant fungus. Essentially, the rotation is designed to take care of any resistant fungus that survived the previous fungicide application by introducing a different fungicide chemistry with a completely different mode of action. Although this is fairly effective, it is not 100%, as it is possible for a phenomenon known as cross resistance to occur. This generally happens within the same chemical family, but if two different fungicides have been tank mixed together, it is possible for that resistance to be established for both modes of action.

### **CIVITAS. Just as effective as the leading brands. With NO resistance issues.**

CIVITAS is a new resistance management tool within an IPM program. Due to its unique mode of action, Induced Systemic Resistance (ISR), CIVITAS enables the turf to fight the disease effectively with its own immune system. When CIVITAS is applied, the plant is put into a ready state where the genes encoding defence proteins are primed for when disease has been detected. When a disease outbreak occurs, these primed genes turn on and start producing the immune response proteins that eradicate the disease.

Here's how CIVITAS drives away fungus.

- ▶ CIVITAS is the first commercially available fungicide for the golf industry based on an Induced Systemic Resistance (ISR) mode of action.
- ▶ Unlike chemical fungicides, CIVITAS does not kill the fungus.
- ▶ CIVITAS is a "plant defense activator" that turns on the natural defenses of the plant to fight off the fungus.
- ▶ Its synthetic isoparaffin-based formulation actually defends against fungus attack. Since the fungus can't gain a foothold, it dies off.
- ▶ CIVITAS strengthens turf quality right down to the roots – you'll notice greener grass in hours.



*The result is effective fungus control... and a healthier, greener course.*

The reason why CIVITAS is an effective resistance management tool with an IPM program is that in the presence of a disease, a large number of genes are activated within the host plant to fight off the disease. This means that when the turf is fighting off the disease, it is very difficult for it to develop multisite resistance. Research to date has shown that CIVITAS fosters no resistance within a range of fungal pathogens, making it an excellent tool to reduce the potential for fungicide resistance.

CIVITAS has undergone robust testing and trial procedures at various universities in the US and Canada throughout six years of research and development. The product was tested by some of the turf grass industry's leading minds, including Dr. Frank Rossi (Cornell University) and Dr. Thomas Hsiang (University of Guelph). In December 2008, Dr. Rossi and Dr. Hsiang co-presented a webinar which detailed their research findings. CIVITAS is available at selected distributors in the United States. Both the webinar and a map to find your local distributor are available at [www.civitasturf.com](http://www.civitasturf.com).