Module 22
Resistance Management

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Reference
For more information on fungicide resistance, please consult the CRI Production Guidelines, volume IV.

Introduction
Resistance to commonly used fungicides in packhouses is becoming problematic for the citrus industry.

It is essential that all packhouse managers must be aware of how fungi develop resistance against fungicides, so that they can manage their applications and dosages to prevent the development and multiplication of resistant strains.

Resistance Building
Any fungus population that has never been exposed to a fungicide, you would expect that most of the individuals in that population would be sensitive to that specific fungicide. However due to natural mutation or just natural variety, you might find that one in a few million of these fungal spores might be resistant to that particular chemical.

Should you now start to use that chemical, in this case in the postharvest environment, obviously the chemical will now kill most of the sensitive isolates, depending on how well you treat it.

It will not kill the resistant one, and the resistant one will be able to multiply. The poorer the application, the more of the resistant isolates in the population will survive and these can then even multiply further.
Types of Resistance

**Disruptive Selection Pressure**

One gets two types of resistance. The first one is called disruptive selection pressure and this is what happens to Thiabendazole (TBZ), which is commonly used against green mould in citrus packhouses.

You will have a population, and as I mentioned earlier, you will have a few resistant isolates in that population, these resistant isolates will be quite remote from the population.

As you use TBZ on this population the sensitive population will start to decline and the resistant one will start to increase.

**Directional Selection Pressure**

The other type of resistance is called a directional selection pressure and this is what happens in the case of Imazalil, which is probably our most important fungicide against green mould.

Because the fungus needs to make a lot more changes to become resistant against Imazalil, you will find that you have a directional selection pressure. So as the fungus makes changes the population shifts towards resistance.

In the case of Imazalil that is why sticking to the correct fungicide dosage is very important, because the lower the dosage, the more of the population will move towards resistance. The better the dosage that you load onto the fruit, the more of the population you will kill.

**Resistance in Practice**

To show what Imazalil resistance in practical terms mean, we have done some trials with Imazalil sensitive and Imazalil resistant isolates. Following treatment with Imazalil, one would hope that you control all the decay. Some decay happens and in the case of sensitive isolates, we get sporulation inhibition, which is one of the most important attributes of Imazalil.
However, in the case of the resistant isolates we can see that we have more decay, as well as loss of sporulation inhibition which is really what we don’t want. So this is the situation with green mould and Imazalil.

We could have similar situations with Thiabendazole and Imazalil, and we might also have it with Guazatine and Imazalil. You can get fungus populations developing resistance against a variety of active ingredients used to control them. It might also happen in other postharvest diseases, although green mould is our most important disease and research is focused on this disease at present.

**Sporulation**

Sporulation is the act or the process during which fungi forms spores.

**Sporulation Inhibition**

Sporulation inhibition is the act or process where fungi can cause some fruit decay, but will not produce spores.

**Managing Fungicide Resistance**

**Fungicide Residues**

So how do we manage fungicide resistance? It is vitally important to get the correct fungicide residue onto the fruit, because the lower the residue that you leave on the fruit, the more of the resistant population will survive.

**Fungicide Usage**

Secondly, it is really important to use a fungicide only once in the packhouse environment. If you use a specific chemical in the drenching system, you should not use the same chemical again in the packhouse environment.

Any resistant spores that survived the treatment in the drench will be taken into the packhouse environment where it will be very difficult to control.
Combined Usage

A third option to manage fungicide resistance would be to use a mixture of two different chemicals to control a specific disease.

In that case it is like a double barrel shotgun: you hit the fungus from two sides. Thereby you would also manage fungicide resistance.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 22.1 – Workplace Interview

Ask a subject matter expert working in your packhouse about his view on how spore populations develop resistance to a certain fungicide. Summarise your findings in your workbook.

Activity 22.2 – Group Activity

In your group, discuss the different ways of managing resistance, with specific reference to the method practiced in your packhouse. Make keynotes in your workbook.
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<th>Details of interviewee</th>
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