Module 20
Hot Water Fungicide Bath

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Reference
For more information on the application of fungicides in the packhouse, please consult the CRI Production Guidelines, volume IV.

Introduction

Fruit coming from the orchard is often to a lesser or greater degree contaminated with fungal spores. These spores are all around us and will cling to any surface and wait for the right conditions to start propagating.

Citrus fruit are vulnerable to fourteen common postharvest pathogens that can infect the fruit, and destroy its internal and external quality. It is important that the fruit is treated to kill the spores, and to inhibit infection and loss of quality.

The main weapon used in the packhouse to fight these pathogens is the hot water fungicide bath. The effectiveness of this treatment depends on three main factors. These are:

- The temperature of the water in the bath
- The concentrations of the fungicides used
- The contact time of the fungicide mixture with the fruit

The fungicide treatment leaves a residue on the fruit that protects the fruit during transit to the overseas market, and the residue will be insufficient if any of the factors mentioned above are neglected.
Water Temperature

Most of the packhouses in the industry use hot water fungicide baths.

Some packhouses prefer to use a cold water bath, but we recommend the use of a hot water bath because hot water serves three purposes. It helps with the drying of the fruit prior to waxing, the uptake of the fungicide into injury points, where there could be an already established infection, and the activity of fungicides is more efficient in a hot water system.

It is important to have the fungicide baths set at the right temperatures. In years gone by, ten years ago, we were recommending temperatures of 40°C, early in the season.

But things have changed through the years. Changing environmental conditions have caused more and more rind conditions on the fruit, and the fruit is becoming more sensitive to these rind conditions. To limit these injuries to the fruit rind we decided to drop the recommended treatment temperature down to between 30 and 35°C.

Contact Time

Another important aspect of the fungicide bath treatment is the exposure time of the fruit in the bath.

Fruit comes through the washing system directly into the fungicide bath were it is exposed to the mixture of fungicides and water. To get the right residue on your fruit it must be exposed to this fungicide mixture in the bath for a sufficient time. The industry recommendation is a minimum exposure time of one minute to ensure effective treatment.

Unfortunately, when baths were developed and introduced into the industry, baths weren't properly researched. Most baths in citrus packhouses are too short, only exposing the fruit to the fungicide mixture for 15 to 30 seconds.

This lack of exposure is reflected in the low residue that is eventually left on the fruit. History has shown us that, throughout the years in the usage of these baths, that when the residue is too low on the fruit it is not the ideal situation. We need to set the right type of residue so the fungicide can do the work properly on the fruit during transit to the overseas markets.
Fungicides

The fungicides cost a lot of money. Packhouses have complained about the costs of replenishing fungicide baths on a daily basis.

In order to make the fungicide mixture last longer, the whole idea is to get your fruit in there as clean as possible. To do this, the washing system is the first line of attack. An effective fruit washing system will get the fruit into the fungicide baths as clean as possible.

Then, with clean fruit entering the bath, packhouses can run a week with a clean fungicide bath and change the fungicide mixture on a weekly basis.

But, at the end of the day, if you have any shortcuts at the beginning of the treatment process, before the fruit is packed for the overseas market, and the fruit arrives in the overseas market in poor condition, poor quality fruit, highly infected fruit, full of waste, who is going to pay for it? It comes back to the packhouse.

Fungicide Concentrations

The most commonly used fungicides in the hot water fungicide bath are Guazatine and Imazalil.

By treating fruit with a too low fungicide concentration, we allow fungi populations to develop resistance. The same applies to contact time and temperature.

The industry recommendation is a contact time of at least one minute, at 30 to 35°C, using a concentration of 500ppm Imazalil and/or Guazatine at a concentration of 1000ppm.

We are dealing with about 12 to 14 different postharvest pathogens, and we have three or four fungicides to take care of these pathogens.

So the packhouse has an option in choosing which fungicides to use where. A number of years ago we were recommending the use of two different fungicides in the bath.
**Fungicide Resistance**

Our most important fungicide is Imazalil. Imazalil takes care of your green and blue mould infections. During the past couple of years we have seen a build up of resistance to Imazalil, so now we have other strategies in place. In order to combat resistance, we introduced Guazatine into the bath as well, which is a fungicide primarily for sour rot, but is very effective against green and blue mould as well.

You now have two different fungicides together in a mixture, which is the preferred way to go to prevent resistance from building up. Both are effective against green and blue mould and have different modes of action. This makes it ideal for one fungicide to knock out Imazalil resistant spores coming into the system, and vice versa with Guazatine resistant spores coming into the system being knocked out by the Imazalil.

**Top-Up Procedure**

It is recommended that you top up the fungicides after a specific amount of fruit has gone through the bath. For example, if you were to pack 60 tons of fruit per a day, you could divide this amount into three, and top up after every 20 tons. Top up according to the stipulated concentration of fungicide to water ratio.

With a mixture of the two fungicides we cannot do the titration to determine the fungicide concentration in the system. So then we have to exclusively rely on topping up procedures and a topping up procedure was worked out in the industry and packhouses have been topping up the fungicide bath according to this procedure.

Also again this procedure is based on a certain amount of tonnage through the bath and the topping up procedure we have has worked fairly well. It is a bit of a thumb suck situation where you do not exactly know that you have the right concentration on your fruit but it has been working pretty well over the years.

More on information on how spore populations develop resistance to certain fungicides can be found in **Module 22 – Resistance Management.**
Titration

A procedure has now become available where the concentrations of both Imazalil and Guazatine in a bath can be tested. This is done by firstly separating the two components and then by using a titration procedure to determine the separate concentrations. If these test cannot be performed then other options are available.

Fungicide Treatment in Wax

To ensure effective treatment, we have recommended that packhouses use Imazalil in the bath on its own, do the titration, top up according to the titration and manage our most important fungicide in the bath on its own, then going to the wax application, and applying the rest of your fungicides in the wax.

So we are withdrawing Guazatine out of the fungicide bath putting it in the wax and using Imazalil on its own and managing the use and the proper effect of your main fungicide which is Imazalil.

Conclusion

Inadequate treatment with fungicides leads to an insufficient residue on the fruit, and increases the development of fungal spore populations that are resistant to a certain fungicide.

It is therefore important that this critical step be monitored effectively through titration, and that adjustments are made on a regular interval to ensure the efficiency of the fungicides used.

It must also be kept in mind that certain markets prohibit the use of certain fungicides and all regulations concerning the use of fungicides must be thoroughly researched before the packing season begins.
Hot Water Fungicide Bath Dos and Don’ts

- Use a **hot water** bath, as opposed to a cold water bath.
- **Water temperature** – 30-35°C
- **Contact time** – at least 1 minute
- **Fungicide concentrations** – Imazalil 500ppm and Guazatine 1000ppm.
- **Effective fruit washing** means the fungicide bath will last longer without being replenished.
- Use **titration** regularly to determine the concentrations of fungicides in the bath, and **top up** accordingly.
- As an **alternative** to having both Imazalil and Guazatine in the hot water bath, **split fungicide applications** between the hot water bath and the wax application.
- Research **market requirements** in terms of the acceptability and residue levels of fungicides.

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**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 20.1 – Practical**

Take a stopwatch and measure exactly how long the fruit in your packhouse spends in the hot water fungicide bath, at different times during shift. Note specifically whether there is a difference between the time spent in the bath if the packline is running at half capacity and when it runs at full capacity. Once you have collected this data, analyse it and express an opinion on whether it is adequate or not. Make recommendations for improvements if necessary.

**Activity 20.2 – Group Discussion**

In your group, note and discuss the fungicides used in your hot water fungicide bath and the monitoring activities that take place to ensure effective treatment. Compare these to the recommendations in this module and note ways in which your system can be improved.
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