# Setting the CATTS among the pests

CATTS on its own is not enough to send internal and external pests packing, but in combination with other post-harvest treatments it can give Japanese plums the protection they require.

**1** Project leader, Dr Shelley Johnson, Dr Mariana Jooste and Renate Smit next to the CATTS equipment.
**2** Late instar false codling moth larva. Preliminary water bath studies showed $4^{th}$ instar larvae to be the most tolerant larval stage.

**THE DANGER THAT** pests and diseases can be transferred from one country to another through international trade in fresh fruit cannot be denied. For this reason, importing countries generally have a zero-tolerance policy towards insect pests that fall under phytosanitary regulations.

Various post-harvest mitigation treatments are used to control phytosanitary pests. Examples include temperature treatments (hot and cold), controlled atmosphere treatments (eg where the $O_2$ concentration is adjusted to 1% and $CO_2$ to 15%), irradiation and chemical treatments (eg fumigation). As the latter becomes less acceptable, the demand for environmentally friendly mitigation treatments – that are effective against insect pests and maintain fruit quality – is growing.

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Cold sterilisation is one of the most highly regarded post-harvest treatments for insect pests. However, effective as it is, cold sterilisation can negatively impact the quality of chill-sensitive stone fruits, such as the Japanese plum cultivars.

Japanese plums are South Africa's most popular plum exports. Yet, because they are so susceptible to chilling injury, certain markets remain inaccessible for South African producers.

As much as Japanese plums cannot withstand cold, studies have shown that these cultivars maintain good fruit quality under heated conditions. For this reason, efforts to solve the problem of meeting phytosanitary requirements while maintaining fruit quality have led researchers to controlled atmosphere temperature treatment (CATTS) technology.

## What is CATTS?

CATTS technology controls phytosanitary pests by combining the effects of a short exposure to high temperature and atmospheric stress. The latter takes the form of a low oxygen (1%)/high carbon dioxide (15%) environment.

In America, CATTS treatments have already been developed to control codling moth and western cherry fruit fly in sweet cherries, and codling moth and oriental fruit moth in apples, peaches and nectarines.

## The potential for plums

At Hortgro Science and Stellenbosch University, studies using a water bath to simulate CATTS treatments were conducted on two plum cultivars and their associated phytosanitary pests. Results indicated that the treatment could be effective.

In a separate study, plums were treated at high temperatures (>40°C) in growth chambers. Evaluations after a five-week cold-storage period followed by a simulated shelf-life period, revealed no chilling injury.

Encouraged by these preliminary results, Dr Shelley Johnson, research fellow at Hortgro Science and Stellenbosch University, and Dr Mariana Jooste proposed further research into CATTS. "The technology provides a mitigation treatment that will allow phytosanitary control for Japanese plums that cannot be cold-stored at -0,6°C for extended periods," Shelley says. "It has, therefore, the potential to open up overseas markets for South African-grown Japanese plums that must be stored under intermittent warming regimes while in transit."

Furthermore, if it can be proven that high-temperature pre-conditioning reduces chilling injury significantly in Japanese plums, the CATTS treatment could replace the currently used intermittent warming regime. The intermittent warming regime causes temperature management problems in the integral containers that are used for the export of Japanese plums from South Africa. These problems could be solved by using a pre-storage high-temperature CATTS pre-conditioning followed by single-temperature storage at 0°C, while still controlling phytosanitary pests.

## Project aim and objectives

The overall aim of the industry and PHI Programme-funded study that Shelley and Mariana designed was to establish the effect of different CATTS treatments in combination with different cold-storage regimes on the mortality of external phytosanitary pests, namely the grain chinch bug (*Macchiadermus diplopterus*) and the banded fruit weevil (*Phlyctinus callosus*), and internal false codling moth (*Thaumatotibia leucotreta*) larvae, as well as on post-treatment plum fruit quality.

To achieve this aim, two objectives were formulated:

1. Determine the effect of different CATTS regimes on external insect mortality and fruit quality.

CATTS research studies in the near future will focus on the establishment of a protocol for controlling internal pests, such as false codling moth, while still maintaining fruit quality.

2. Determine the effect of different CATTS treatments and storage regime combinations on plum fruit quality and mortality of FCM larvae.

## Methodology

Initially, the Japanese plum cultivars 'Laetitia' and 'Songold' were selected for Objective 1, and 'Songold' for Objective 2. However, pilot trials found that the proposed treatments led to unsatisfactory post-treatment fruit quality. As a result, a late plum cultivar 'Flavour Fall' was selected for the trials.

The fruit was exposed to different temperature treatments in combination

**PROJECT TITLE**
CATTS as a post-harvest treatment for chill-sensitive plum cultivars and associated phytosanitary insect pests.

**PRINCIPAL INVESTIGATOR**
Dr Shelley Johnson

**CONTACT DETAILS**
+27 (0)21 808 2694
sjohnson@sun.ac.za

**DURATION**
Three years

**PHI PROGRAMME & INDUSTRY CONTRIBUTIONS**
R417 228 & R267 228

**LEAD INSTITUTION**
Hortgro Science

**BENEFICIARY**
The South African stone fruit industry

**FOCUS AREA**
Post-harvest insect control, including phytosanitary compliance, and post-harvest physiology

**HUMAN CAPITAL DEVELOPMENT**
One PhD student (upgraded from MSc level)

**PUBLICATIONS**
Three

**PRESENTATIONS**
Four

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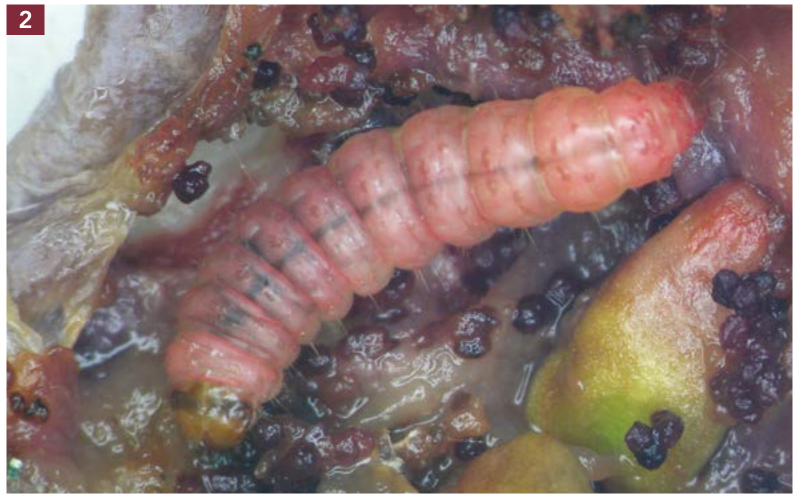

**1** Probes inside the CATTS drawer with fruit measures air temperature, surface temperature and core temperature near the stone of the plums.
**2** 'Songold' plums are hydro-cooled with water at 0°C immediately after CATTS treatment to prevent pit burn and external heat damage.
**3–4** Inoculation of 'Songold' plums with FCM larvae.

> "The intermittent warming regime causes temperature management problems in the integral containers that are used for the export of Japanese plums from South Africa. These problems could be solved by using a pre-storage high-temperature CATTS pre-conditioning followed by single-temperature storage at 0°C, while still controlling phytosanitary pests."
>
> Dr Mariana Jooste

with controlled atmosphere, and then cold stored using two different cold-storage regimes, namely cold sterilisation and intermittent warming.

For all treatments, fruit quality was evaluated after treatment application, after storage and after cold-storage plus shelf-life simulation.

The CATTS trials were carried out in a laboratory-scale CATTS chamber, which is a flow-through, airtight system with computerised temperature, dew point and atmosphere controls. Air inside the chamber is injected with nitrogen, carbon dioxide and synthetic air, humidified by micro-misting nozzles and passed over a heater element to increase air temperature. The chamber can accommodate two plastic trays of fruit.

## Results and conclusions

CATTS provides a non-chemical alternative to control various pests, while also reducing horticultural products' rate of maturation and their susceptibility to chilling injury. It is, however, not the answer to all phytosanitary and fruit quality problems.

In this study, none of the CATTS treatments achieved a 100% mortality rate on the three insect pests that were tested. Banded fruit weevil adults were the most successfully eliminated and required lower temperatures and shorter treatment durations than either false codling moth or grain chinch bug.

The researchers concluded that CATTS treatment may not be a stand-alone solution to control grain chinch bug especially, given that it proved to be the most difficult to destroy completely with the selected treatments while maintaining fruit quality. However, given the success of other treatments, such as ethyl formate fumigation, to control this external pest, the focus for CATTS can be shifted to controlling internal pests, such as false codling moth.

In terms of fruit quality, adjustments will have to be made to the rate of heating, as well as the maximum hold temperature, to prevent external and internal heat damage to the fruit. Hydro-cooling with water at 0°C immediately after CATTS treatment is strongly recommended to prevent pit burn and external heat damage.

The incidence of shrivel in 'Flavor Fall' and 'Songold' should be addressed with better handling and packaging protocols in order to prevent the extreme moisture loss that was observed.

**5** Small containers filled with the external insect pests and bagged FCM-infested fruit are placed among 'Flavor Fall' plums inside the chambers of the laboratory-scale CATTS machine.
**6** Plums that show external heat damage. Cooling with water at 0°C immediately after CATTS treatment could prevent this condition.
**7** Pitburn occurs when the stone becomes warmer than the flesh and literally burns the fruit tissue.
**8** Severe internal heat damage in a plum that was subjected to temperatures above 35°C for several hours.
**9** These plums show internal heat damage that resulted from exposure to high temperatures during CATTS treatment and no hydro cooling thereafter.