fresh NOTES
a technical update published by HORTGRO science

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Quality management of plums following heat waves during the harvesting season

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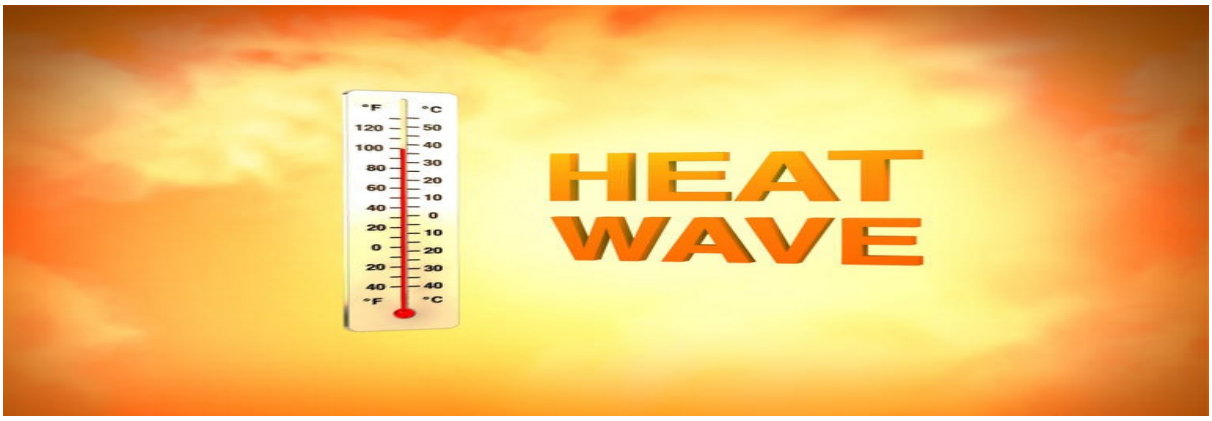

The primary fruit quality aspects to be managed during heat waves are sunburn, internal heat damage, gel breakdown, over-ripeness and shrivel.

Pre-harvest

Growing conditions and cultivars

- Heat damage is most likely to occur on plums following heatwaves
- Climate during the growing season plays a role when heat damage will occur in plums as plums will acclimatize to an extent in warmer seasons. Generally heat waves that may lead to heat damage in plums can be defined as follows:
    - Temperatures of approximately 35°C for 3 consecutive days
    - Temperatures of approximately 38°C for 2 consecutive days

  - Temperatures of approximately 40°C for 1 day

- Cultivars grown on ridges and in sandy soil, particularly 5-8 days prior to ripening are more likely to develop heat damage and these orchards should receive first attention.
- All plum cultivars may develop heat damage. Due to the likelihood of heatwaves in January and February the later cultivars could be more affected. The more susceptible cultivars are Sapphire, if there are early heatwaves, and Fortune and Laetitia.
- Orchards under drip irrigation where soil profile is dry prior to heat are vulnerable to heat damage.

Preventative strategies for heat related disorders during the pre-harvest phase

- It is of the utmost importance to know when heatwaves may occur as many of the preventative measures must be taken before the heat wave actually occurs.
- For this reason accurate weather prediction information must be obtained throughout the growing season.
- The susceptibility of plums to develop heat damage increases as the fruit matures. Therefore, if heatwaves are expected, the first option is to harvest as much of the plums that conform to the maximum maturity standard before the heatwave occurs.
- Research has shown irrigation to 100 % of field water capacity at least 1 day and preferably 2 to 3 days prior to the expected heatwave will reduce heat damage. This will create a buffer as the atmospheric evaporative demand on trees during heat waves will be higher than normal.
- Pulsed irrigation (every hour for five minutes if possible) during the heatwave is believed to reduce orchard temperatures and heat damage on the plums may be reduced (NB 11h00 – 15h30). Under drought conditions, such pulsed irrigation may not be possible – producers should then rather strive to have the soil at field capacity prior to the expected heat wave as per the previous point.
- Harvesting of plums during a heatwave should be restricted to the cooler part of the day, maturity permitting, and the guidelines for field heat removal in the post-harvest section of this communication should be followed.

  Heat waves cannot be prevented but the negative effect on plum quality can be reduced if the correct precautionary measures are followed.

Post-harvest:

From a post-harvest point of view, the following aspects are important to minimize the effect of heat waves on fruit quality.

- Heat damage on plums can manifest in different forms. The easiest to detect is external heat damage observed as discoloured areas on the surface of the fruit, typically caused by direct sun light on the fruit. These “discolorations” tend to sink into the flesh tissue of the fruit during storage. If detected, fruit

exhibiting these symptoms must be removed from the pack line and must not be packed for marketing purposes. This is typical for cultivars such as Songold.

- With African Delight plums, sunburn may manifest as typical yellow skin discolouration. This can develop into a brown discolouration on the epidermis during cold storage.
- The more difficult type of heat damage to detect, and the one that may cause greater losses, is internal heat damage that occurs in the flesh tissue (mesocarp). Internal heat damage often manifests when ambient air temperatures rise above 35^{0}C for 3 consecutive days, 38°C for two days or 40°C for a day. The preceding temperatures will also play a role in the susceptibility of the plums to heat damage. Due to low vapour permeability, mature fruit have a low ability to cool through evaporation of water from the fruit surface. This results in the temperature in the fruit sometimes exceeding ambient air temperate by as much as 15^{0}C. This simply "cooks" the internal tissue and the result is internal tissue damage. Fortune and Laetitia plums, in particular, are known to be susceptible.
- Fruit at optimum or post-optimum maturity are much more susceptible to internal heat damage than fruit at pre-optimum maturity or green fruit at the time of the heat wave. For this reason fruit picked within 7 days after a heat wave often show more heat damage symptoms than fruit picked later.
- Fruit picked after extreme heat conditions also tend to ripen faster and this can lead to more gel breakdown as well as overripeness and shrivel.

Management of heat related disorders during the post-harvest phase

Field heat removal and packaging

- For fruit packed on the harvest day, a delay time of between 4 and 6 hours between harvest and packing is recommended. Research has indicated that this is beneficial for internal quality maintenance. During this delay time, bins can be placed in a draft in the shade and the objective is to allow the fruit to lose field heat and cool down.
- Field heat can also be removed from the plums by placing the bins in a cold store at 12 to 15°C (above dew point). This will result in the lowest possible moisture loss in fruit packed 24 to 36 hours after harvest. Relative humidity in the cold stores should be above 90%.
- Fruit should not be placed at -0.5°C for short periods (6 to 12 hours) prior to packing as this may lead to more moisture loss, softer fruit, more internal problems and more decay. These negative effects on fruit quality were shown to be less if the period at -0.5°C is extended to 48 hour or more. Field heat removal at -0.5°C is therefore only recommended if fruit cannot be packed within 48 hours after harvest. However this practise may increase decay due to condensation on the fruit.
- The preferred options, especially in fruit picked after heat waves, in terms of internal quality and moisture loss, are therefore to pack the fruit within 4 to 6 hours after harvest, or to remove field heat at 15°C and pack the fruit within 48 hours after harvest.

- In shrivel prone cultivars it is imperative to use the correct internal packaging to limit moisture loss. The packaging recommendations are available on the Hortgro website.

Forced-air cooling and cold storage

- The optimal cooling time to the target cold storage temperature of –0.5°C is 24 to 48 hours. Too rapid cooling can result in an increase of internal disorders. In the case of plums with suspected heat damage, research has shown that significantly lower levels of internal damage are likely to occur in plums cooled in 48 or even 72 hours, compared to plums cooled in 24 hours or shorter (Mariana Jooste & Arrie de Kock). Slower cooling rates will not reverse heat damage in plums that already exhibit internal problems at harvest, but seem to assist in controlling the problem in cases where damage is not yet visible at harvest.
- Heat damage normally manifests after cooling. For this reason, it is advised **to cut** and examine fruit, harvested after a heat wave, after cooling, to visually inspect the internal quality before shipping, to establish if internal heat damage has occurred.
- Heat damage normally occurs in the mesocarp between the stone and the epidermis. However, it can also occur in on the shoulders of the fruit, or in the stem end of the fruit. In cultivars like African Delight it may also occur as brown spots randomly in the mesocarp tissue. For this reason it is important to cut fruit through the equator, through the shoulders and in four quarters if the temperatures preceding harvest were conducive for heat damage.
- With dual-temperature stored cultivars, it is important to limit the period at –0.5°C to a maximum of 10 days after harvest. Chilling injury, typically in the form of internal browning, may develop in plums if the period at –0.5°C is extended beyond 10 days before the plums are warmed to 7.5°C. The tolerance of plums to –0.5°C prior to the warming phase will depend on the inherent fruit quality as well as cultivar.
- Because heat damage usually increases during cold storage, cold storage of plums that was exposed to extreme heat prior to harvest should be as short as possible.