Shade nets light the way to avocado quality

Nets that manipulate light to the benefit of the plants that grow under them is not science fiction. It is a new agro-technological concept that is boosting the post-harvest quality of 'Hass' avocados.

1 Project leader, Prof. Dharini Sivakumar.
2 For this study, an avocado orchard of 1,15ha was covered with different colours of photo-selective netting. Depending on the colour used (red, yellow, green, blue, white, grey or pearl), the nets manipulate light quality to induce favourable responses in plants.

TOO MUCH HOT sunshine, wind and hail can inflict damage on avocados that detracts from their marketability long before they arrive at the packhouse. Nets are an obvious solution to these problems and are widely used on farms to physically protect crops against the elements of nature, as well as external pests.

Recent research, however, suggests that nets can do more than just protect. By filtering and manipulating light, they can make a material difference to fruit quality.

Photo-selective coloured netting is a new agro-technological concept. Depending on the colour a producer chooses (red, yellow, green, blue, white, grey or pearl), the nets manipulate light quality to induce favourable responses in plants.

According to Prof. Dharini Sivakumar, SA Research Chair in Phytochemical Food Network to Improve Nutritional Quality for Consumers, at the Department of Crop Sciences, Tshwane University of Technology, photo-selective netting can improve the post-harvest physiology of fruit to obtain reduced physical damage and incidence of post-harvest diseases, and improved ripening patterns.

The technology is based on plastic net products into which various chromophores and light dispersive and reflective elements are introduced during manufacturing. The nets are designed to screen various spectral bands of solar radiation, and/or transform direct light into scattered light. The spectral manipulation promotes desired physiological responses that are light regulated, while the scattering improves the penetration of the modified light into the inner plant canopy.

"The available literature on photo-selective nets definitely points to the fact that the modification of light quality and micro-climate conditions caused by these nets can improve the fruit quality both at harvest and during post-harvest storage," says Prof. Sivakumar.

She points out that the word "quality" includes the nutritional value of fruit. Studies Prof. Sivakumar previously carried out on tomatoes and sweet peppers have proven that the manipulation of light quality through the use of photo-selective netting can improve the dietary phytochemical composition of the produce. "Strengthening avocados' growing reputation as a health-promoting food is thus further motivation to conduct in-depth research into the influence of photo-selective nets on post-harvest storage quality," she says.

Although avocados are not grown under netting in South Africa, growers' interest in this technology is mounting as they seek to reduce the physical damage that hail, wind and sun cause.The interest would increase exponentially if photo-selective nets prove to be an opportunity to increase exports by improving pack-out rates and ripening patterns, while decreasing post-harvest losses due to defects and decay in the packhouse, and improving the nutritional status of the fruit.

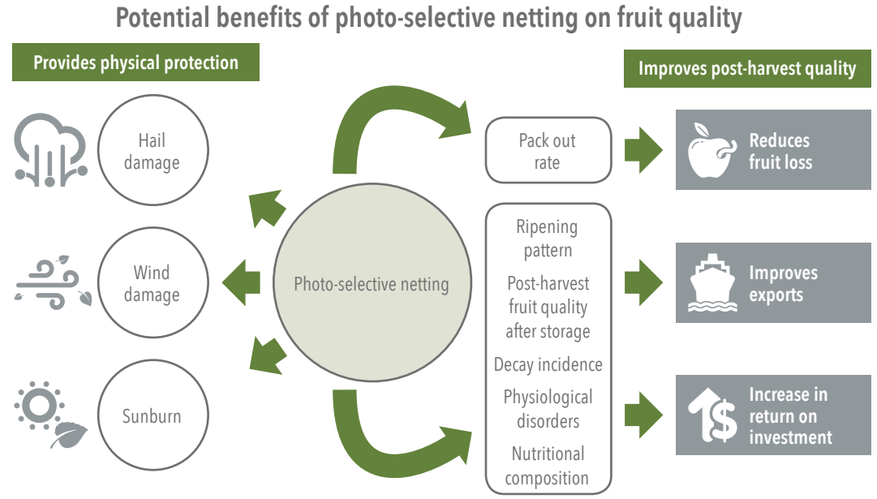
The research study

Building on previous research findings, Prof. Sivakumar led a study jointly funded by the PHI Programme and industry to investigate the effect of different colours of photo-selective shading nets on the post-harvest quality of 'Hass' avocados. Working with her were Dr Zelda van Rooyen from Westfalia Technology Services, and Peter Tinyane, a PhD student.

The study set out to measure:

- The incidence of sun damage, dry matter and oil content of the fruit, resulting in improved pack-out rates.
- Post-harvest fruit quality parameters, namely fruit firmness, incidence of anthracnose, stem-end rot, number of days to ripen after harvest and after cold-storage, ethylene emission, incidence of physiological disorders (vascular browning, grey pulp), and eating quality.
- Post-harvest fruit quality parameters (same as above) in avocados that are subjected to the ready-to-eat ripening programme (Westfalia fruits).
- The status of dietary phytochemicals and fatty acid composition, cell wall softening enzymes and antifungal compounds after post-harvest storage.

Prof. Sivakumar emphasises that the study outcomes were not only focused on the improvement of pack-out rates. "We wanted to address the ripening quality of 'Hass' avocados, especially in the context of ready-to-eat programmes."



HOW THE SUN INFLUENCES AVOCADOS

Previous studies have shown that pre-harvest exposure to the sun influences post-harvest responses of 'Hass' avocados. Higher fruit surface temperatures caused by prolonged exposure to sunlight delay ripening, affect the enzymes that soften cell walls, and increase the fruit firmness in avocados. Exposure to higher temperatures can, therefore, negatively affect the ready-to-eat ripening programme.

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PROJECT TITLE
Photo-selective nettings to improve post-harvest fruit quality of 'Hass' avocados

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DURATION
One year and ten months

PHI PROGRAMME & INDUSTRY CONTRIBUTIONS
R407 210 & R197 210

LEAD INSTITUTION
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BENEFICIARY
The subtropical fruit industry

FOCUS AREA
Post-harvest physiology and pre-harvest aspects

HUMAN CAPITAL DEVELOPMENT
One D-Tech student

PRESENTATIONS AND PAPERS DELIVERED
Two

PUBLICATIONS
Pending


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Methodology and results

Photo-selective nets were installed at a Lombard's farm in the Tzaneen area of the Limpopo Province during January 2015. Over the next two years, Prof. Sivakumar and the student who worked with her monitored the micro-climate that was created under the nets, as well as the post-harvest quality of the avocados that were grown there.

Quality and pack-out rates were measured by sorting 60 to 80 avocados per replicate net in the packhouse in order to identify sun-damaged fruits. The total number of marketable fruit – according to SAAGA standards – was determined over two years.

To determine the impact of the nets on post-harvest quality, 100 disease-free uniformly shaped avocados, without any injuries or defects, were selected per experimental unit. The fruit was stored separately for all the parameters. Subsequently, a set of 14 fruits was packed in commercial cartons and stored at 5,5°C and 85% relative humidity for 28 days, and thereafter at 25°C to simulate market shelf conditions. At the end of the storage period, the fruit was evaluated for chilling injury, number of days to ripen, fruit firmness after storage and at ripe stage, and the fruit quality parameters (incidence of anthracnose, stem-end rot, flesh colour, and eating quality).

For the ready-to-eat ripened avocados, the same methodology was followed, except that the storage period at 5,5°C was 21 days, instead of 28. Following that, the fruit was subjected to commercial ripening. After ripening, the fruit was evaluated for anthracnose and stem-end rot incidence, fruit firmness (softness), and eating quality.

Analyses of the dietary phytochemicals, fatty acid composition, non-structural C_7 sugars, and antioxidant capacity were done on a set of 16 fruits per replicate net.

The researchers found that shade nets significantly reduced sun damage. The different colour nets delivered different results:

- Total yield was lower under the pearl net.
- Pack-out rate was higher under the blue and white nets.
- Fruit size distribution was better under the blue net.
- Post-harvest ripening was delayed in fruits produced under the pearl and red nets, and in the open field.
- Oleic acid was high under the white net, whereas major phenolic acids, vitamin E, and C_7 sugars were high under the red net and in the open field.

Based on their results, the research team concluded that blue and white photo-selective nets improved yield and pack-out rates, and can be recommended for growing 'Hass' avocados.

LEARNING FROM OTHER CROPS

Research projects on the effect of photo-selective netting on the post-harvest quality of tomatoes, sweet peppers, lettuce varieties and aromatic herbs have been carried out by the Department of Crop Sciences, Tshwane University of Technology, between 2010 and 2016.

Results obtained over two growing seasons showed that different tomato cultivars responded differently during post-harvest storage. The photo-selective nets improved the marketability of the crops after low-temperature storage more so than the commercially used nets. The incidence of post-harvest decay and physiological disorders were significantly reduced, and at least one the cultivars' dietary phytochemicals were improved under the photo-selective nets.

1 Too much sunlight damages avocado skin, delay ripening and affect the enzymes that soften cell walls.
2 A set of 16 fruits per replicate net was selected and analysed to determine the composition of dietary phytochemicals, fatty acids, sugars, and antioxidants.
3 White nets improve yield and pack-out rates, while red nets (**4**) delay post-harvest ripening.
5 For his PhD thesis, Peter Tinyane investigated the influence of photo-selective shade netting on the quality of avocados at harvest and during post-harvest storage.

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