Photo-selective nettings to improve postharvest fruit quality of avocados cv. Hass

PP Tinyane[1], Z van Rooyen[2] and D Sivakumar[1]

[1] Department of Crop Sciences, Tshwane University of Technology,
Private Bag X680, Pretoria 0001, SOUTH AFRICA
[2] Westfalia Technological Services,
Westfalia Fruit, Tzaneen, SOUTH AFRICA
E-mail: sivakumarD@tut.ac.za

ABSTRACT
During the 2015 – 2016 growing seasons a study was undertaken to investigate the effect of photo-selective coloured shade nets (red leno and pearl leno) (20% shading) on fruit size (diameter), marketable yield, sunburn and wind damage, ripening pattern and postharvest quality (fruit firmness, incidence of diseases) at ready-to-eat stage for avocado cv. Hass. Open field and widely used common white and blue Knittex nets (20% shading) were included for comparison. Overall, 20% shading remarkably reduced the sun damage and improved the marketable total yield. However, the pack-out rate was remarkably higher when fruit were produced under the white and blue nets. Although the pack-out rate and the fruit count distribution differed during 2015 and 2016 trials, the trends were more or less similar in both seasons. In 2016 during harvest, blue nets had more preferred fruit count for the commercial market, followed by the white nets. The open field produced fruit were small in size. Fruit obtained under the blue net and the open field ripened faster than the fruit from the other type of nets, but the ripening was delayed for the fruit from the red nets.

INTRODUCTION
Avocado fruit quality for marketing can be affected by physical damage due to higher summer temperatures, as well as wind and hail during production. The increase in fruit surface temperature and higher solar radiation can result in sunburn damage (Fig. 1 A & B) and affect the pack-out rate and marketability of the fruit (Blakey *et al*., 2015). Exposure of fruit to higher temperatures during growth was reported to show variability in ripening patterns and fruit firmness and can affect the present 'ready to eat programme'. When selecting shade nets for fruit production, growers must be aware of the importance of shading intensity and colour of the nets. Shade nets are commonly used to protect agricultural crops from either excessive solar radiation, environmental hazards, or pests. Shading intensity and the colour of the nets play a major role in modifying the light quality and the microclimate of that environment. These factors can directly influence the fruit quality parameters and ripening pattern. Producing fruit that meet export standards is beneficial; increasing the export of avocados and providing growers with a good return on investment. Furthermore, Blakey *et al*. (2015) reported that shade nets can prevent the higher sun or wind damage fruit by reducing the wind speed and the rate of evapotranspiration. This study was initiated in year 2015 and the first year data was reported in 2016 (Tinyani *et al*., 2016). Photosynthetically active radiation (400 to 700 nm) is the amount of light available for photosynthesis. The light quantity (PAR) was higher in the open field and less or more or less similar under the 20% shade nets (Tinyani, 2016). This report includes the second growing season (2017) data. Therefore, the objectives of this investigation are to evaluate the effect of different spectral shade nets on micro climate, fruit surface temperature, percentage transmittance of radiation, light quantity, total yield, marketable yield and fruit quality according to different export grades at harvest, as well as the ripening pattern during post-harvest storage.

MATERIALS AND METHODS
Trial site
Lombard Avocado farm in Tzaneen, Limpopo Province (23.7° South latitude, 30.13° East longitude and 986 m elevation above sea level) was chosen for the study. The farm is situated in New Agatha, Tzaneen. The orchard is affected by sunburn on fruit, by wind and by regular hailstorms.

Trial details of different coloured shade nets and experimental design
The trial was based on cultivar Hass. Randomised Complete Block Design (RCBD) was adopted. Each treatment (20% red leno net, 20% pearl leno net [Ginger plastics, Kibbutz, Israel], 20% Knittex white net, 20% Knittex blue net [Knittex Ltd South Africa], no net [open field]) replicated five times in five blocks. Trees were spaced 7 m by 4 m, south-north (S-N) orientation. The nets were erected horizontally at about

6-7 m above ground. The whole trial occupied about 1.15 ha. Within each net section, only the central six trees in each treatment were evaluated.

Data gathering similar to year 2016

The following data were obtained: light quality and micro-climate, fruit assessments for sun, wind, disease and pest damage, total fruit yield, marketable yield, pack out rate according to the different grades and fruit sizes (counts).

Postharvest trial as reported previously by Tinyani *et al*. (2016) in similar manner disease-free uniformly shaped or sized fruit without any injuries or defects were selected and a set of 300 fruit per specified colour shade net (red, pearl, white or blue net) and open field were packed for postharvest storage trials; the fruit were laid out in a completely randomised design. A set of 14 fruit were packed in commercial cartons and stored at 5.5°C and 85% RH for 28 days. Thereafter at 25°C to simulate market shelf conditions (postharvest storage). After completion of low temperature storage, fruit were held at simulated market shelf condition at 18-20°C. At the market shelf condition, the fruit were evaluated for number of days to ripen, and fruit firmness was recorded after storage and at the ripened stage. The quality of the ripe fruit was assessed daily by gentle hand-squeezing as mentioned previously (Tinyani *et al*., 2015). Fruit firmness was measured at two points of the equatorial region of the fruit by using a Chatillon Penetrometer, Model DFM50, with an 8 mm diameter flat-head stainless-steel cylindrical probe (puncture method), and the results were reported in kilograms. Fruit firmness of 1 kg represented soft, ripe fruit (Standard ISO 7619, International Organization for Standardization).

RESULTS AND DISCUSSION

Fruit surface temperature and light quantity

The average fruit surface temperature was much higher in the open field (30-32°C), moderately lower under the red net (25-29°C), lower under the blue net (24-26°C), lower under the white nets (23.3-25.6°C) and lower under the pearl nets (22-23.6°C) during March to July in the 2015 growing season (Table 1).

The % transmittance of UV radiation (290-400 nm) was higher in the open field (Fig. 2) and similar observation was reported in 2016 (Tinyani *et al*., 2016). The UV radiation was remarkably reduced under the pearl nets and moderately reduced under the blue and white nets (Fig. 2). It is evident from this study that the fruits from the open field were repeatedly exposed to higher UV radiation during the fruit growth period, which showed an increase in the fruit temperatures from February till the harvest in July. The fruit quality under the shade nets are shown in Figure 3.

Table 1. Fruit surface temperature under the shade nets.

	Feb-April	April-May	June-July
Open field	32 °C - 35 °C	29 °C - 33 °C	29 °C - 30 °C
Red nets	29 °C - 32 °C	26 °C - 30 °C	20 °C - 25 °C
Pearl nets	29 °C - 26 °C	22 °C - 25 °C	16 °C - 20 °C
White nets	27 °C - 30 °C	25 °C - 27 °C	18 °C - 20 °C
Blue nets	27 °C - 30 °C	25 °C - 27 °C	20 °C - 22 °C

Figure 1A. Sunburn damage on the fruit initiates as yellowish green due to discolouration of green pigment (chlorophyll) in the skin.

Figure 1B. Fruit that are categorised as waste during pack house sorting.

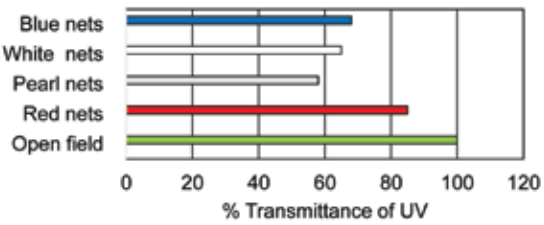

Figure 2. Percentage transmittance of UV light in open field and under the shade nets.

Figure 3. Fruit quality under the shade nets.

Fruit maturation, total yield at harvest and pack out rate

The trend in fruit maturation was similar to 2016 (Tinyani *et al*., 2016). Therefore, the detailed information is not mentioned here. The total yield at harvest in the open field was higher (Fig. 4). However, in 2016 the yield under the red net was higher than the blue and white nets. The total yield was low under the pearl net. This could be due to the alternative bearing pattern of the trees.

The pack-out rate was higher under the blue nets and white nets and was categorised as class 1. A high waste (industry grade fruit) was observed in the open field compared to the nets (Fig. 5); this was mainly due to sunburn damage (77%).

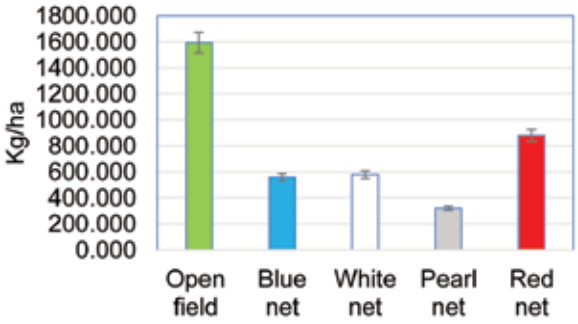

Figure 4. Influence of shade nets on the total yield in 2016.

Figure 5. Percentage of waste fruit during pack house sorting.

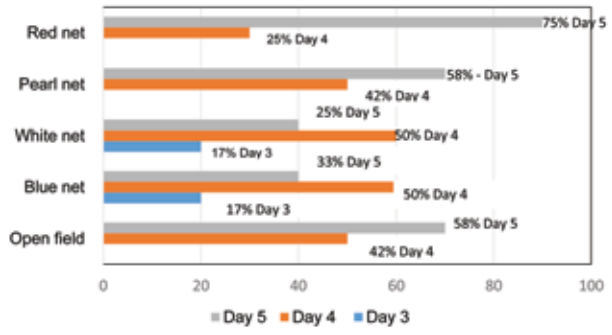

Figure 6. Fruit ripening pattern and number of days taken for ripening.

Larger fruit (count 8 or 10) were neither observed in the open field nor under the different coloured shade nets. The fruit size distribution of the open field fruit showed mostly count 20. Fruit size distribution trend was similar to 2016. Fruit size distribution under the blue nets showed 27% count 18, 17% count 16 and 13% count 20. The fruit size distribution under the pearl net showed 29% count 16, 18% count 18 and 16% count 22. The red nets showed 16% of fruit belonging to count 18, 20 and 22. Under the white nets, fruit size distribution was 20% count 18, 17% count 22, 15% count 16 and 17% count 22. Therefore, under the white nets the shift in fruit size distribution is towards average size (medium) fruit, preferred for the commercial market.

Postharvest fruit quality

Fruit from the blue and white nets started to ripen on the 3rd day and the ripening continued on the 4th and 5th days. Fruit from the red and pearl nets started to ripen on the 4th day and on the 5th day all the fruit were ripened. Fruit from the open field ripened on the 4th and 5th day and 58% of the fruit were ripen on the 5th day. However, fruit from the red nets showed delayed ripening and 75% of the fruit ripened on Day 5. Percentage of fruit ripened over the period of 5 days is showed in Figure 6.

Moreover, fruit from the white nets ripened faster; hence they would be suitable for the 'ready to eat ripening programme'. Fruit firmness was higher in fruit produced under the red and pearl net. The fruit from the blue and white nets however showed ±1 kg, which corresponds to our last year's report (Tinyani *et al*., 2016).

In conclusion: pack-out rate is severely affected due to sun damage. Growing cv. Hass avocados under the white and blue (Knittex) nets could provide a solution, reducing the sun burn damage and improving the pack-out rate. However, as mentioned by Blakey *et al*. (2015), measures should be in place to improve the pollination in order to meet the projected total yields at harvest. In our trials it was noted that the alternative bearing had more influence on the yield.

REFERENCES

BLAKEY, R.J., VAN ROOYEN, Z., KOHNE, J.S., MALAPANA, K.C., MAZHAWU, E., TESFAY, S.Z. & SAVAGE, M.J. 2015. Growing avocados under shade netting in South Africa. VIII Congreso Mundial de Palta. 230-235.

TINYANE, P.P., MAKWAKAWA, M., VAN ROOYEN, Z. & SIVAKUMAR, D. 2016. Influence of photo-selective shade netting to improve fruit quality at harvest and during postharvest storage. Research Report 2016.