Reducing environmental stress to increase avocado yield and fruit quality

Progress report – Year 1

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ABSTRACT

The management of environmental or abiotic stress is a means to reduce the risk of crop loss and damage, and increase profitability in avocado production. Two approaches are investigated in these trials: shadenets and chemical manipulation. Shadenet structures were erected over a 'Carmen®-Hass' orchard in Mooketsi, Limpopo Province, and a 'Gem'™ orchard in Karkloof, KwaZulu-Natal Province, to determine the long term effects on yield, pollination, cultural management, fruit quality, maturity and tree physiology. Another structure was constructed at Schagen in the Mpumalanga Province, while another will be completed at the end of 2014 near Tzaneen Dam, Limpopo Province. The trials will also compare structural design and economic benefit of the shadenet structures. The chemical manipulation section will examine the effect of glycine betaine (a natural osmolyte) on fruit drop, yield and subsequent flowering of avocados. Some provisional results are presented, but these trials have not been harvested yet and results will be presented in following reports.

INTRODUCTION

Shadenet

Solar radiation in South Africa is excessive for optimal avocado tree growth and development, resulting in heat and light stress for the trees, and fruit damage. Wind, hail and frost are environmental risks affecting avocado production. A shadenet structure over an avocado orchard can provide protection from these factors and reduce tree and fruit damage and should thereby improve profitability. However, there are questions about the use of shadenets for avocados in South Africa which need answers before large scale use of shadenets over avocados should be considered:

1. What is the return on investment?
2. How are flower development, pollinators and pollination affected by the nets?
3. How is fruit maturity affected?
4. How is cultural management affected?
5. What is the best structural design and how long does it last?

Shadenet has been used extensively for citrus and grapes in South Africa because of the improvement in production and fruit quality compared to these crops but extrapolation from citrus is limited because of differences in the anatomy and physiology of avocado (Schaffer *et al.*, 2013).

Chemical manipulation

Environmental stress during flowering and fruit set can reduce pollination, increase November fruit drop, increase small fruit from premature seed coat senescence and ultimately reduce yield. Glycine betaine (GB) is a naturally occurring osmolyte in plants that is produced in response to drought, salinity and heat stress (Ashraf & Foolad, 2007). In theory, an increase in the foliar concentration of GB will allow the plant to transpire and photosynthesise for a longer period in the day, reducing stress, ABA synthesis and thereby reducing fruit drop.

AIMS

Shadenet

1. Determine the long term effect of shadenet over avocado orchards on yield, pollination, cultural management, fruit quality, fruit maturity and tree physiology.
2. Examine different construction methods and nets.
3. Estimate the economic benefit of installing these shadenet structures.

Chemical manipulation

1. Determine the effect of glycine betaine on fruit drop, yield and subsequent flowering in 'Hass' avocados at both a higher and lower environmental stress orchard.

MATERIALS AND METHODS

Trial 1: Shadenet

Two contrasting trial sites at Westfalia Fruit Estates were chosen. Goedgelegen Estate in Mooketsi, Limpopo, with a hot, dry, windy climate, and Everdon Estate in Karkloof, KwaZulu-Natal, with a cool subtropical climate with regular hailstorms and winds and cold stress in winter. 'Carmen®-Hass' at Mooketsi was chosen because it is an early Hass-like cultivar and this orchard is beset by wind and sunburn of fruit. 'Gem'™ was chosen because it is a late blackskin cultivar and the orchard is affected by wind, hail and, potentially, cold damage. Subsequently two sites were added to the trial: an 8 ha structure next to Tzaneen Dam, Limpopo, which will be planted in 2014/15, and a 30 ha structure at Schagen, Mpumalanga, erected over mature 'Pinkerton' and 'Hass' orchards (Table 1). The level of monitoring will be different at each site, with the most intensive monitoring being done at the Mooketsi, Tzaneen and Karkloof sites.

There were unfortunately delays in the construction of the nets due to severe storms which damaged existing structures (belonging to other growers) which needed to be repaired. As such, the structure at Everdon (Karkloof) is not erected at the time of publication but will be complete in the first quarter of 2014.

Trial 2: Chemical manipulation

Two trial sites were selected: Ballygowan, adjacent to Tzaneen Dam, and Goedgelegen Estate in Mooketsi. Goedgelegen was chosen because, of the Westfalia Fruit Estates farms, the environmental (abiotic) stress is highest. The climate is drier with some salt stress. Ballygowan was selected because the trees are mature but un-encroached and the site has lower environmental stress than Mooketsi, but fruit also reaching maturity relatively early in the season. Both orchards are 'Hass'. Glycine betaine (Greenstim®, Nanturf) was applied twice at 50% flowering and 11 or 14 weeks thereafter according to Table 2. Only half of the trees at Mooketsi were sprayed twice. Nu-Film P sticker was added at 40 mL/100 L.

Tree health, flower intensity and flower stage of each tree was recorded before spraying, before November drop and again before harvest. At the time of writing, trees had not been harvested.

RESULTS AND DISCUSSION

Only some provisional results are available in this report. Further results will be published in the following report.

Shadenet

Maturity

The shadenet appears to have hastened fruit maturity (estimated using moisture content) and by week 8 the two open orchards had not reached minimum maturity of 77% MC while the 6 m x 3 m orchard under shadenet reached minimum maturity in week 6 and the 3 m x 3 m orchard under shadenet reached 77% in week 8 (Fig. 1). However, fruit quality upon ripening should be considered in conjunction with moisture content; these results will be available in the next report.

Fruit quality

Although the structure at Goedgelegen (Mooketsi) was only covered after fruit set, the number of fruit with external damage (wind damage and sunburn) is (visually) reduced, especially compared to the open 6 m x 3 m planting where the fruit are more exposed. These fruit are scheduled for harvest in mid-March 2014.

Construction

If a grower is contemplating erecting a shadenet

Table 1. Trial details for shadenet trials at Mooketsi, Karkloof, Tzaneen and Schagen.

Location	Cultivar	Area	Spacing	Shadenet	Height
Mooketsi	Carmen®-Hass	1 ha	3 m x 3 m 6 m x 3 m	20% white	6.5 m
Karkloof	Gem™	1.5 ha	7 m x 4 m	30% crystal	6.5 m
Tzaneen	Hass Maluma Carmen®-Hass A0.12	8 ha	8 m x 4 m	20% white & 30% crystal	7 m
Schagen	Pinkerton Hass	30 ha	6 m x 3 m 6 m x 3.5 m 7 m x 5 m	30% black & white	5.6 m 6 m

Table 2. Application details for glycine betaine (Greenstim®) for two sites.

Site	Tree size	Rate	Volume	Application date	Evaluations
Tzaneen Dam	Small	5.0 kg/ha	2000 L/ha	Week 34 & 45	Week 34, 40 & 10
Mooketsi	Large	7.5 kg/ha	3000 L/ha	Week 31 & 45	Week 30, 42 & 7

structure, the choice of contractor and the specifications of their structure (anchors, cables, poles and net) are critical for the longevity of the structure – especially if storms and high winds are expected. The longevity of the different structures will be compared to be able to make a recommendation for future shadenet structures.

Glycine betaine

No results are available for the Greenstim® trial at the time of going to press as fruit will only be harvested in the second quarter of 2014. Results will be presented in subsequent reports. It may be necessary to spray the second application sooner, but this will be confirmed after the first season's data.

CONCLUSION

The horticultural, physiological and economic aspects of these long-term trials will be forthcoming in the coming years. However, appreciably visual observations indicate that the shadenet has reduced wind damage and sunburn at Mooketsi.

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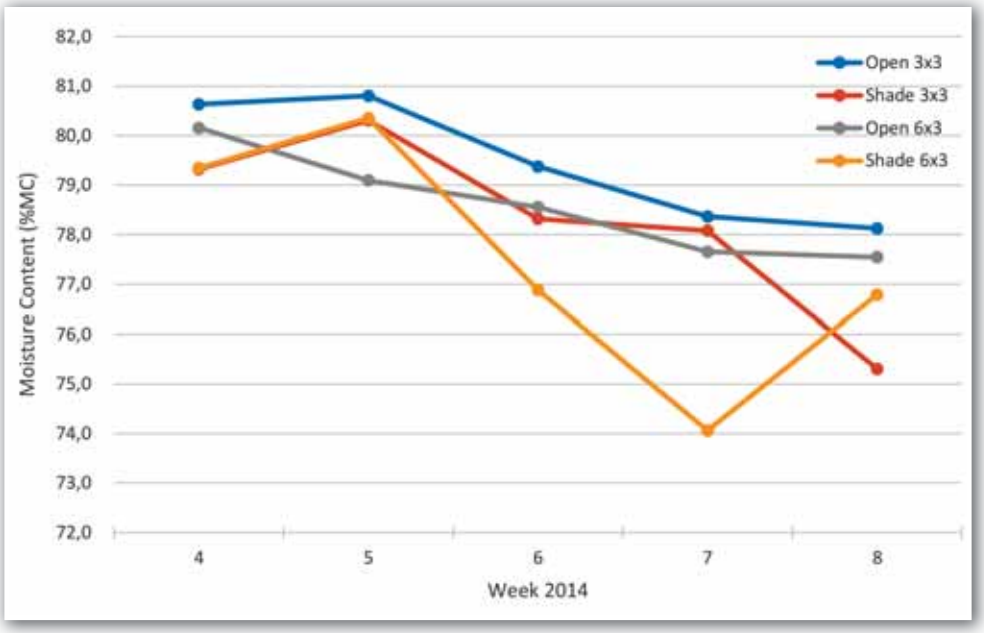

Figure 1. Moisture content of four 'Carmen®-Hass' orchards in Mooketsi, under net and open, at two tree spacings, from week 4 to week 8 in 2014. Five fruit were used per sample, standard deviation is 2.0% MC.