Observations on the effects that row orientation, ridging and orchard altitude have on avocado production in the Tzaneen area

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ABSTRACT

A survey was performed to establish the relative importance of row orientation, ridging and orchard altitude on avocado production in the Tzaneen area. To do this, the annual commercial yield data of, respectively, 4 'Pinkerton' orchards located at ± 700 m altitude; 32 'Hass' orchards located at ± 700 m and 20 'Hass' orchards located at ± 1 400 m were processed. The survey confirmed that a north-south orientation holds a ± 50% advantage over an east-west orientation. Preliminary observations indicated that ridging provides a yield related advantage that may be related to non-exposure to the water table. Higher lying orchards were further found to not only yield more than lower lying orchards, but their proportional decrease in yield was less during an off-year. During the 2019 season, this was attained through increased fruit size in the high-altitude trial orchard. Appropriately structured trials aimed at determining optimal ridge heights and orchard altitudes are presently being performed with the Hass cultivar.

INTRODUCTION

The authors are currently conducting a project aimed at determining the effect that ridges have on avocado tree health and yield (Kruger and Volschenk, 2019). In an attempt to obtain supplementary information on the topic, it was decided to collect additional retrospective data on the production figures of avocado orchards in the Tzaneen area.

This report deals with yield recordings made of 'Pinkerton' orchards located at ± 700 m in the Tzaneen area over the last decade. The results were supplemented with data from a set of 'Hass' orchards located in the same production unit, as well as from a second 'Hass' production unit located at ± 1 400 m. The effects of row orientation, ridging and orchard altitude are discussed.

MATERIALS AND METHODS

'Pinkerton' yield recordings

The four 'Pinkerton' orchards referred to in the present study are located in a production unit located at ± 700 m in the Tzaneen area. They are referred to as the 'Blue', 'Red', 'Purple' and 'Green' orchards. The orchards are adjacent to each other and were planted during 2008 at a spacing of 10 m x 2.5 m (Fig. 1). The orchards do, however, vary in terms of their row orientation and the presence/absence of ridging:

- The 'Blue' orchard was planted in a north-northwest to south-south-east direction without ridging (referred to as north-south)
- The 'Red' orchard was planted in a north-northwest to south-south-east direction without ridging (referred to as north-south)

Figure 1: Satellite image of the four 'Pinkerton' orchards used to illustrate the proportional effects of the different factors on yield

- The 'Purple' orchard was planted in a west-southwest to east-northeast direction without ridging (referred to as east-west)
- The 'Green' orchard was planted in a west-southwest to east-northeast direction (referred to as east-west). Twenty percent of this orchard was ridged prior to planting while the remaining eighty percent of the orchard was left unridged.

The annual yields for the four orchards were recorded and the cumulative yield calculated. This was expressed as a percentage of the yield of the orchard with the highest cumulative yield over the 11-year period.

'Hass' yield recordings

In the case of 'Hass', the annual yields of 32 orchards located in the same ± 700 m production unit were obtained. The annual yield was expressed as a proportion of the mean yield recorded over the last five years.

In addition to the above, the annual yields of the above orchards were compared to those recorded for 20 'Hass' orchards located in a production unit established at ± 1 400 m in the same district.

RESULTS AND DISCUSSION

The cumulative yields of the four 'Pinkerton' orchards in the 700 m production unit are shown in Figure 2. The results are herewith discussed in terms of the influence that three aspects may have had on the cumulative yield.

The first of these is orchard orientation. In Figure 2 it can be seen that, as can be expected, no fruit were borne during the first two years after planting. However, as from year three, the two north-south orientated orchards ('Blue' and 'Red') consistently yielded just short of 50% more than the two east-west orientated orchards ('Purple' and 'Green'). In the case of the Green orchard this continued until year 7, while the trend was evident until year 11 in the Purple orchard.

This observation supports the current practice of designing orchards in such a way that the rows are as close as possible to a north-south orientation.

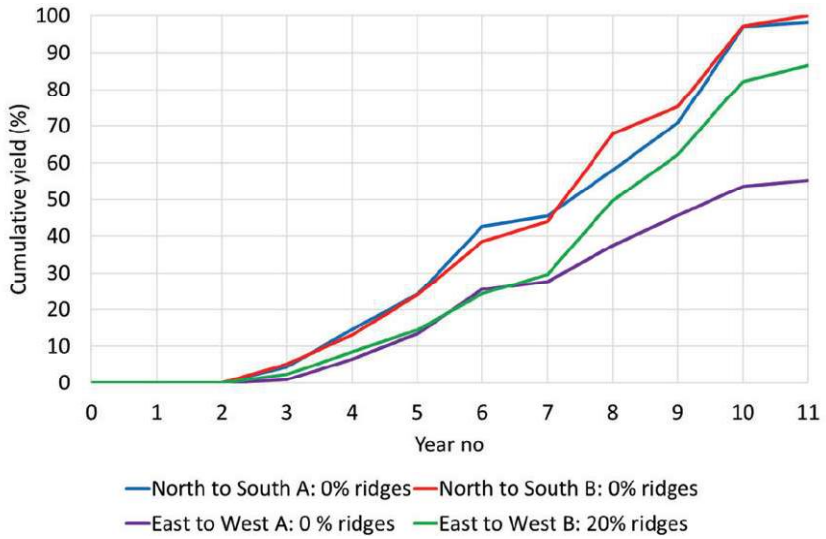

Figure 2: Cumulative yields recorded in four 'Pinkerton' orchards over an eleven-year period. The orchards are referred to as the "Red", "Blue", "Green" and "Purple" orchards in the text. The yield is expressed as a percentage of the highest cumulative yield ("Red" orchard: year 11)

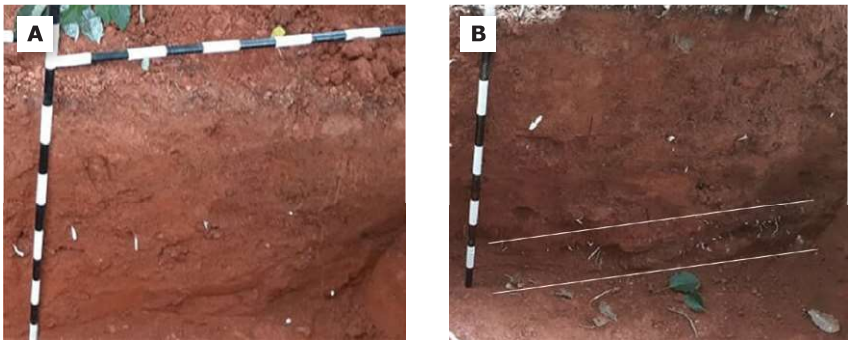

Figure 3: Profile pits that were dug in flat ground (A) and in a ridge (B). The pits were dug parallel to the row direction, ± 600 mm from the stem. The outside surface areas of the pits are shown in the photo. The white lines indicate a band of finer roots that occurred inside the ridges just above ground level

The second aspect involves ridges. The Green orchard (20% ridges) produced similar to the Purple orchard during the first seven years (Fig. 2). However, during year 8, the annual yield of this orchard started to increase and it continued to yield approximately 50% more than the Purple orchard until 2019. A number of scenarios were considered as to what the yield in the Green orchard would have been should the whole orchard have been ridged. However, we would first like to harvest the two treatments separately over a number of seasons before making any further deductions.

Interesting observations were made regarding the location of the roots inside the ridges (Fig. 3). Profile pits dug next to non-ridged trees revealed a sparsely populated layer of lateral roots at approximately half a meter. This layer was also present under the ridged trees. However, the ridged trees developed a second layer of fine roots at the intersection between the ridge and the ground level. This is quite a significant observation, as this represents a well-watered zone just above ground level (highest mark the water table can reach). In addition to production related benefits, this location may hold anti-pathology related benefits as well.

In addition to the above two aspects, Figure 2 exhibits an additional trend we refer to as the effects that "tree energy levels" have on yield.

As mentioned above, the two north-south orientated orchards' cumulative yield were similar after the 11-year survey period. However, a number of relatively small but important fluctuations occurred over this period. From year 3 to 5, the two orchards had similar yields. During year 6 the Blue orchard yielded slightly more than the Red orchard. They then converged during year 7, after which the Red orchard's yield exceeded that of the Blue orchard during year 8. After this they again converged.

From the above it would appear that, when viewed in a longitudinal perspective, two similarly designed orchards have similar amounts of energy at their disposal. Although one orchard may yield more than the other during a specific season, the additional energy used to do this will result in this orchard bearing less than its peer during the next season. In the long run, the orchards will have similar cumulative yields.

This was not only the case with 'Pinkerton', but all cultivars showed this trend. The relative yield graphs of 32 'Hass' orchards located in the same ± 700 m production unit over the last 5 years are shown in Figure 4. As may be deduced from the graph, the individual orchards in the production unit showed a zigzag yielding pattern similar to the above 'Pinkerton' orchards during the 2015-2019 period. This alternate bearing pattern was caused by the percentage of trees in each orchard that were either in the "on-" or "off-phase" during any given year (results not shown).

Another important observation that closely relates to the above, is the fact that all four 'Pinkerton' orchards showed a reduction in yield during the 2019 season (Fig. 2). This trend was mirrored by the 'Hass' orchards (Fig. 4). During 2019, the yield of those orchards of which most trees were in the off-phase during 2018 (and the yield was expected to increase during the 2019 season) remained stable or showed a small reduction. In step with the above, the yield

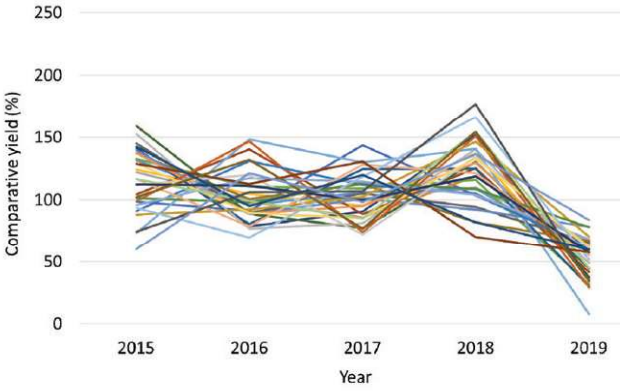

Figure 4: Comparative yields of 32 'Hass' orchards located in a production unit established at ± 700 m in the Tzaneen area over a five-year period. In each case, the mean yield was calculated for the whole period after which each year's yield was expressed as a percentage of the mean of each individual orchard

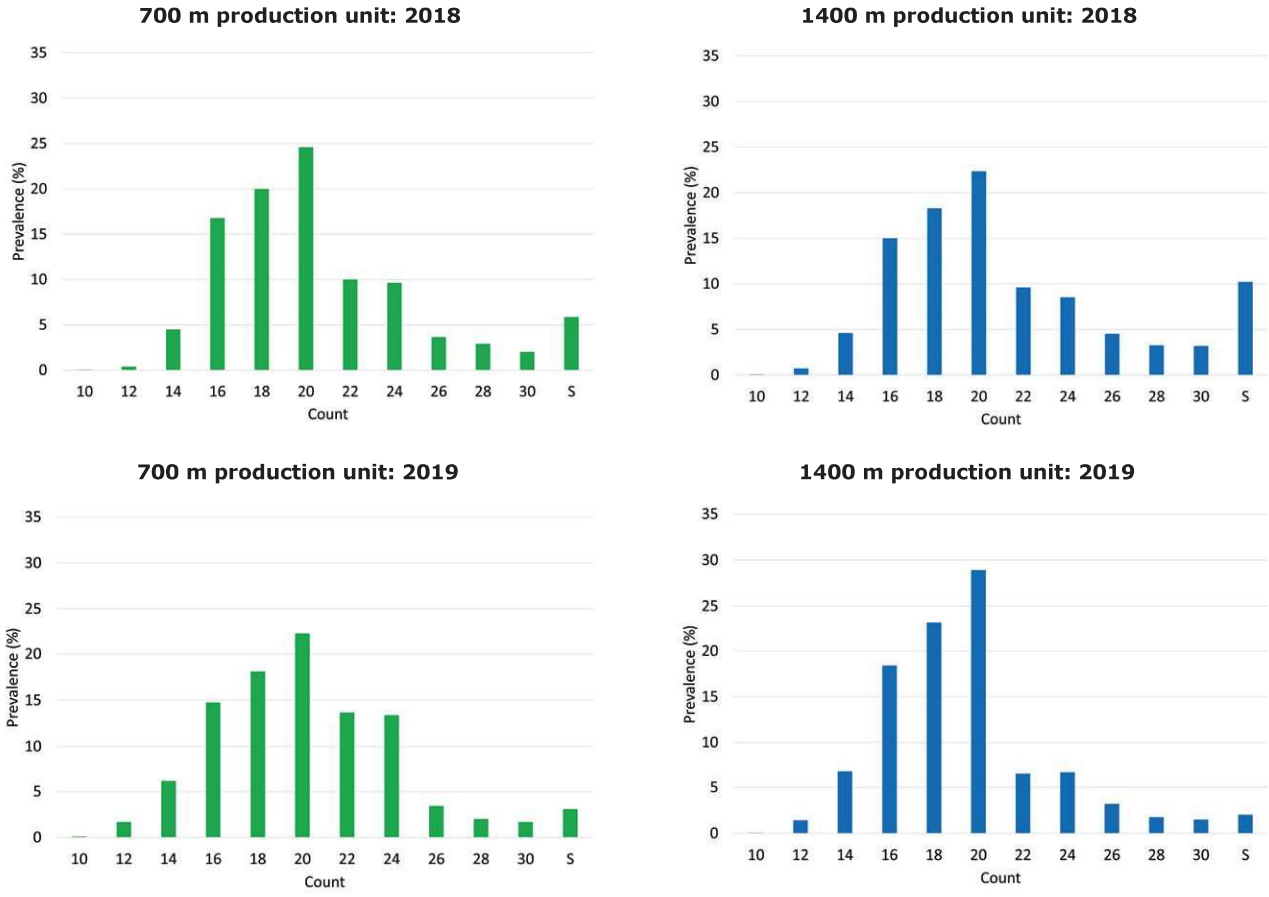

Figure 5: Count distribution of 'Hass' fruit from production units located at, respectively, ± 700 m and ± 1 400 m during the 2018 and 2019 seasons

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Table 1: 'Hass' yields recorded in two avocado production units in the Tzaneen area. The first is located at ± 700 m while the second is to be found at ± 1 400 m. In each case the yield is expressed as a percentage of the maximum yield (± 1 400 m unit during 2018 = 100%)

Yield per production unit per year		
Production unit altitude (m)	700	1400
Relative yield 2018 (% of max)	53	100
Relative yield 2019 (% of max)	26	69

of those orchards where a slight downtrend in yield was predicted, reduced to a greater extent than during the previous four years. It would thus appear that the production unit "ran out of energy" during the 2019 season. This was reflected in the fruit's sugar content levels (Kruger *et al.*, 2020).

It is interesting to note that well managed 'Hass' orchards, such as those located in the current ± 700 production unit, showed a greater reduction in yield during 2019 than their higher yielding peers located at ± 1 400 m (Table 1). The ± 700 m production unit showed a 50% reduction in yield from 2018 to 2019, while a higher bearing unit located at ± 1 400 m registered a 30% decrease only.

It is interesting to note that, during 2019, the higher lying orchards were able to make up for the loss in yield by an increase in fruit size, while this was not the case in the lower lying orchards (Fig. 5). This most probably also ties up with the higher TSS levels observed in these orchards during the 2019 season (Kruger *et al.*, 2020).

Further research

In so far as ridge height/volume is concerned, a trial has been laid out to determine what effects this aspect has on avocado tree health and yield. A similar trial is being performed on macadamia (Kruger and Kuperus, 2019). It is interesting to note that, in contrast with the current survey, a significantly higher macadamia yield was recorded from the ridges during the first year of bearing. It is therefore imperative that the avocado yields from the experimental block (Kruger *et al.,* 2019) be determined over the next couple of years before an empirical conclusion is made regarding the perceived benefits of ridges.

In terms of orchard altitude, a trial has been launched that examines orchards at a series of altitudes ranging from 600 m to 1 600 m. Aspects that are being monitored include maturation rate, storage potential, ripening rate and taste.

Acknowledgements

The authors would like to thank all contributors and funders, as well as Mark Penter who edited the manuscript.

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