Titel: The commercial experience with ‘Carmen-Hass®’ and ‘Gem®’ under different planting densities

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THE COMMERCIAL EXPERIENCE WITH 'CARMEN-HASS®' AND 'GEM®' UNDER DIFFERENT PLANTING DENSITIES

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SUMMARY

In South Africa, two new avocado cultivars, Mendez #1 (Carmen-Hass®) and 3-29-5 (Gem®) were introduced and commercialised by Westfalia Technological Services (WTS) in the last decade. 'Carmen-Hass®' and 'Gem®' plantings expanded to 300 and 250 ha respectively in South Africa by 2018. Commercial experience with different planting densities for these cultivars is limited. The objective of the study was to establish the most suitable planting density for these cultivars. A commercial trial planting was established for each cultivar consisting of 3 planting densities on two rootstocks (Dusa™ and R0.06). Two different geographical locations were used with the 'Carmen-Hass®' planting in a warm subtropical area of Limpopo Province and the 'Gem®' planting in a cool high lying area of KwaZulu Natal Province in South Africa. Tree performance in terms of yield, fruit size and fruit quality were monitored over several seasons**.** The 'Gem®' trees on R0.06 rootstock consistently produced higher yields than trees planted on Dusa™. As can be expected, an increase in yield ha^{-1} was seen with an increasing number of trees ha^{-1} for both cultivars at first. However, a negative effect on the yield of 'Carmen- Hass®' was seen after 4 seasons at the highest planting density as a result of overcrowding. This was not yet seen in the 'Gem®' plantings. A medium planting density is more suitable for 'Carmen-Hass®' in the long term while 'Gem®' trees can be maintained at a higher planting density for longer without compromising yield.

Key words: overcrowding, tree structure, vigour, yield

EXPERIENCIA COMERCIAL CON 'CARMEN-HASS®' Y 'GEM®' CON DISTINTAS DENSIDADES DE PLANTACION

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Durante la última década, dos nuevos cultivares de aguacate, Mendez # 1 (Carmen-Hass®) y 3-29-5 (Gem®) , fueron introducidos y comercializados por Westfalia Technological Services (WTS) en Sudáfrica. La superficie plantada en Sudáfrica con 'Carmen-Hass®' y 'Gem®' se expandió a 300 y 250 ha respectivamente al año 2018. La experiencia comercial de estos cultivares con distintas densidades de plantación es limitada. El objetivo del estudio fue establecer la densidad de plantación más adecuada para estos cultivares. Se estableció un ensayo comercial para cada cultivar consistente en 3 densidades de plantación sobre dos portainjertos (Dusa ™ y R0.06). Se utilizaron dos ubicaciones geográficas diferentes, la plantación de 'Carmen-Hass®' se localizó en un área subtropical cálida de la provincia de Limpopo y la plantación de 'Gem®' en una zona fresca y alta de la provincia de KwaZulu Natal

en Sudáfrica. El comportamiento de la planta en términos de rendimiento, tamaño de los frutos y calidad de la fruta fue monitoreado durante varias temporadas. Los plantas de 'Gem®' sobre el portainjerto R0.06 presentaron consistentemente mayores rendimientos que las plantas sobre Dusa ™. Como se puede esperar, al principio se observó un aumento en el rendimiento ha^{-1} con un número creciente de árboles ha^{-1} en ambos cultivares. Sin embargo, se observó un efecto negativo en el rendimiento de 'Carmen-Hass®' después de 4 temporadas con la mayor densidad de plantación, como resultado del emboscamiento. Esto aún no se ha visto en las plantaciones de 'Gem®'. Una densidad de plantación media es más adecuada para 'Carmen-Hass®' a largo plazo, mientras que los plantas de 'Gem®' pueden mantenerse a una mayor densidad de plantación durante más tiempo sin comprometer el rendimiento.

Palabras clave: emboscamiento, estructura de árbol, producción, vigor

Introduction

Westfalia Fruit Estates has been actively searching for superior avocado cultivars for ca. 35 years. A formal cultivar evaluation programme was introduced in the early 1990's. The twofold aim of this programme was to find high yielding, good quality and robust cultivars to compliment the traditional cultivar spread and extend the traditional season with earlier or later maturing cultivars. Many cultivars have been screened over the years but failed in some respect. These reasons include poor productivity, poor external fruit appearance, undesirable fruit shape and size, pest and/or disease susceptibility and poor post-harvest fruit quality (Kremer-Köhne, 1999 and Kremer-Köhne, 2001).

However, an import by Westfalia Technological Services (WTS) from California, Mendez #1 (Carmen-Hass®), passed all the screening tests and came through as the most promising early season Hass-like cultivar screened in over 20 years. Likewise, 3-29-5 (Gem®) also imported by WTS from California proofed to be a worthy fit for the late South African season (Bruwer & Mokgalabone, 2004). Both these cultivars were subsequently commercialised by Westfalia Technological Services (WTS) in the last decade (Bruwer *et al.*, 2015). 'Carmen-Hass®' and 'Gem®' plantings expanded to 300 and 250 ha respectively in South Africa by 2018. Commercial experience with different planting densities for these cultivars is limited. The objective of the study was to establish the most suitable planting density for these cultivars under South African growing conditions.

Materials and Methods

A commercial trial planting was established for each cultivar consisting of 3 planting densities on two rootstocks (Dusa™ and R0.06). Different geographical locations were used for each cultivar to complement their season of maturity. The planting with the early maturing cultivar Carmen-Hass® was done in a warm subtropical area of Limpopo Province and the late maturing 'Gem®' planting was done in a cool high lying area of KwaZulu Natal Province in South Africa. The 'Carmen-Hass®' planting was established in 2011 at a 7m x 4m, 8m x 4m and an 8m x 5m spacing regime relating to 357, 312 and 250 trees ha^{-1} respectively. For the Gem® cultivar, planting densities used were 8m x 3m (416 trees ha^{-1}), 7m x 3m (476 trees ha^{-1}) and 6m x 3m

(555 trees ha^{-1}). The trees were established during November 2010 and consisted of approximately 250 trees per rootstock/plant spacing regime.

Tree performance in terms of yield, fruit size and fruit quality were monitored over several seasons. For each planting density/rootstock treatment, 50 data trees were selected, and individual tree yield was collected. Observations were made in terms of encroachment or overcrowding in the different planting densities.

Results and Discussion

Carmen®-Hass

At Westfalia Fruit Estates, some of the old, poor performing orchards were removed as part of an orchard rejuvenation programme. As part of this programme, a 7ha area was cleared, re-developed and the 'Carmen-Hass®' trial planting was established in 2011. Due to it being a re-plant orchard, high root disease pressure was prevalent and tree establishment was slower and more difficult than expected. However, a first good crop was harvested in the 2014 season and data was collected for 5 seasons until 2018.

In general, the trees produced well, and yield between the treatments was similar for the first two seasons except for the lower yield of the Dusa™ trees of the 8m x 5m spacing (Figure I). The third season (2016) was an "off-season" for all the treatments (9 – 23 kg $tree^{-1}$), except for the R0.06 trees in the 8m x 4m spacing which produced 55 kg $tree^{-1}$. Despite the "off-season" crop, a general trend towards a higher yield for the wider spacings can be seen from here onwards. Exceptions to this can be seen with the 2017 yield of the Dusa™ trees in the 8m x 5m planting (25 kg $tree^{-1}$) and the R0.06 trees from the 8m x 4m planting (28 kg $tree^{-1}$). The Dusa™ trees were mistakenly used as a budwood source during the 2016/17 season and thus had a negative impact on the 2017 yield and the R0.06 trees now had an "off-season" crop after two consecutive years of good crops.

By 2017, the 7m x 4m spaced trees, have filled the in-row spaces and some pruning was performed to maintain the between row area. Even though the in-row spacing is also 4m for the medium plant density, individual tree canopies could still be distinguished, and no pruning was needed to maintain the between-row area. For the widest spacing of 8m x 5m neither the in-row spaces nor the between-row spaces were overcrowded.

By the end of 2018, only the individual tree canopies of the 8m x 5m spacing could still be identified. In the 7m x 4m spacing, die back of branches in the lower, inside area of the trees were seen. This can be attributed to poor light penetration due to the dense canopies and 7m row width, compared to the 8m row width for the 8m x 4m spacing.

Inconsistent results were seen between the different plant densities in terms of which rootstock is the best performer. For the closest spacing (7m x 4m), the Dusa™ rootstock out-performed the R0.06 rootstock for most of the years, while the R0.06 rootstock out-performed the Dusa™ rootstock in the widest spacing (8m x 5m) for all the years. For the medium density (8m x 4m), the rootstocks performed very similar in terms of cumulative yield (Figure I). These differences

can probably be explained by the overcrowding that started settling in for the closest spacing (7m x 4m) and more so for the planting on the more vigorous R0.06 rootstock.

The positive impact of a denser plant spacing can clearly be seen when individual tree yield (average kg tree^{-1}) is converted to ton ha^{-1} for the respective plant densities. Even though the densest plant spacing (7m x 4m) had the lowest cumulative yield tree^{-1} (159-175 kg tree^{-1} vs. 215 – 252 kg tree^{-1}), it still compared well with the other treatments when the yield was converted to ton ha^{-1} (Figure II). However, the best treatment was the medium plant density where both rootstocks fared equally well and out-produced the other two plant densities with at least 4 ton ha^{-1} over the period of evaluation.

Gem

The 'Gem' trees planted in KwaZulu Natal in November 2010 as part of a new development on virgin soil, established well and trees on the R0.06 rootstock flowered and set fruit in the 2012/2013 season. A small crop of 0.3 - 0.4 ton ha^{-1} was harvested during 2013. This came as no surprise since the Gem cultivar is known to be a precocious bearer. This result indicates that the behaviour is more pronounced in trees grafted on the R0.06 rootstock than on the Dusa™ rootstock.

All the trees produced a crop in the 2014 season, with the lowest producer being the trees in the closest spacing (6m x 3m), followed by the trees in the medium spacing (7m x 3m) and the best producer being the trees of the widest spacing (8m x 3m) This trend continued in 2015, but in 2016, the trees in the closest spacing out-performed the trees in both the other spacings (Figure III). Generally, 2017 was an 'off-season" for 'Gem' with the medium spacing out-performing the other spacings with around 10 kg tree^{-1}. In 2018, the widest spacing out-performed the medium and closest spacing. In terms of cumulative yield over the 6 seasons, the widest and medium spacings were the best performers, but when the average yield tree^{-1} is converted to ton ha^{-1} for the respective plant densities the higher number of trees in the 6m x 3m planting swings it in favour of the closest planting density (Figure IV).

It is clear from the data, that 'Gem' performs better on rootstock R0.06 than on the Dusa™ rootstock. 'Gem' on R0.06 out-performed 'Gem' on Dusa™ with 11%, (6m x 3m spacing), 16% (7m x 3m) and 7% in the 8m x 3m spacing (Figure IV).

Conclusions

The results from the two plant density trials showed that tree performance under different planting densities are comparable for at least 3 seasons after establishment. For 'Carmen-Hass®', which have a wide spreading canopy, a between row spacing of 8m was best, since the 7m row width resulted in overcrowding and more severe pruning at a fairly young age was needed to maintain proper light penetration. From visual observations, the spacing of 5m between the 'Carmen-Hass®' was too wide as the trees did not even completely fill the in-row spaces by year 7 after planting. Thus, in a warm subtropical climate, an 8m x 4m planting density is best suited for 'Carmen-Hass®'. 'Gem®' on the other hand, due to its upright and less vigorous growth habit is well suited to be planted at higher planting densities in order to maximise on productivity. 'Gem®' trees can easily be maintained at a planting density of 6m x 3m (no overcrowding seen after 8 years) with no compromise on productivity.

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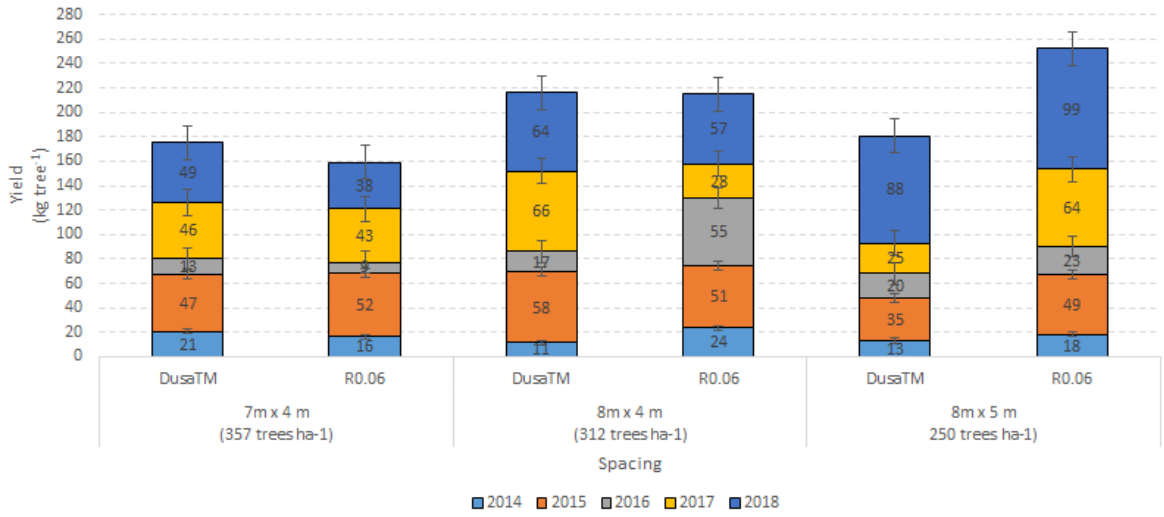

Figure I. 'Carmen-Hass®' yield for 3 planting densities (7m x 4m, 8m x 4m and 8m x 5m) and two rootstocks (Dusa™ and R0.06). Data is expressed as the average kg tree^{-1} for each rootstock/density treatment.

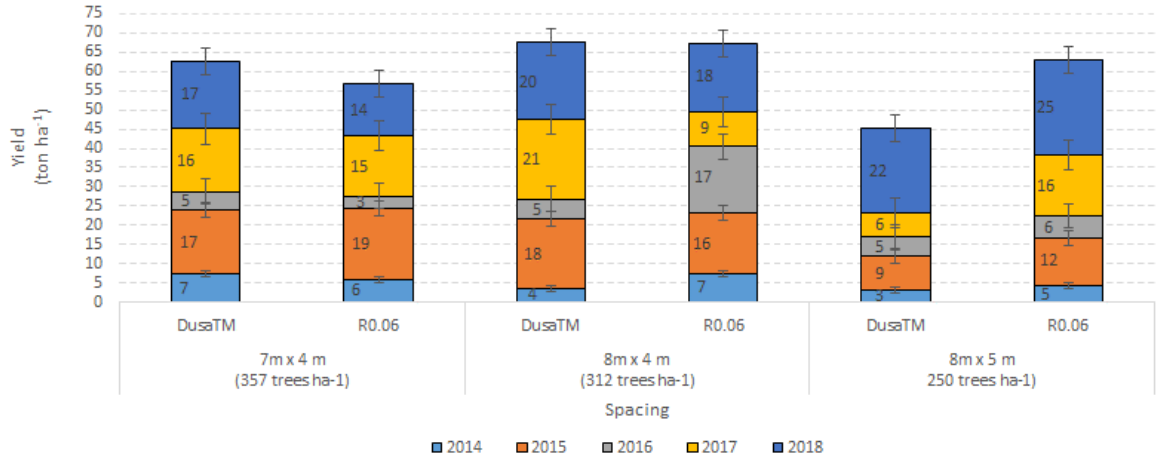

Figure II. 'Carmen-Hass®' yield for 3 planting densities (7m x 4m, 8m x 4m and 8m x 5m) and two rootstocks (Dusa™ and R0.06). Data is extrapolated to ton ha^{-1} for each rootstock/density treatment.

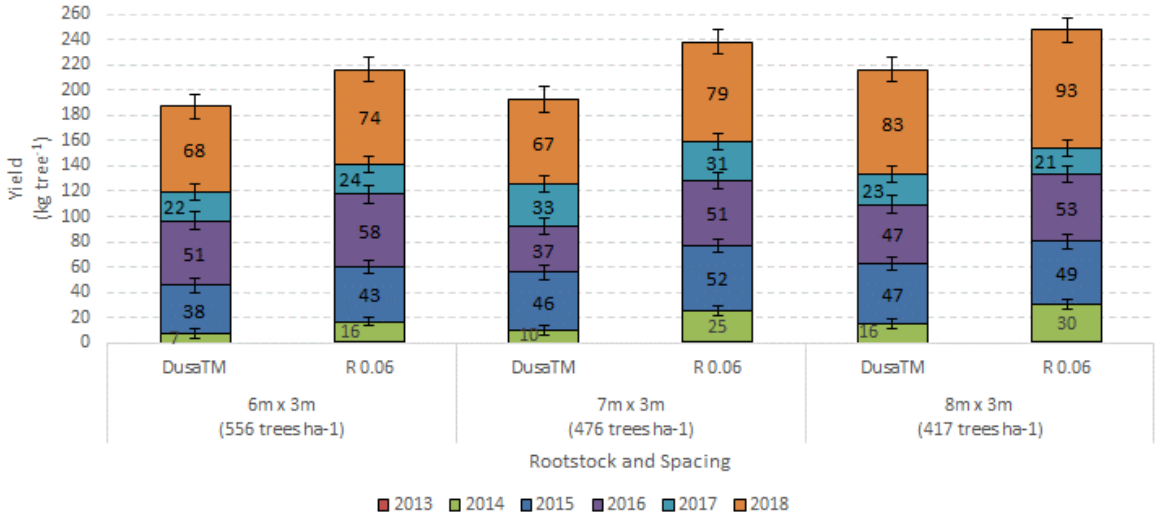

Figure III. 'Gem®' yield for 3 planting densities (6m x 3m, 7m x 3m and 8m x 3m) and two rootstocks (Dusa™ and R0.06). Data is expressed as the average kg tree^{-1} for each rootstock/density treatment.

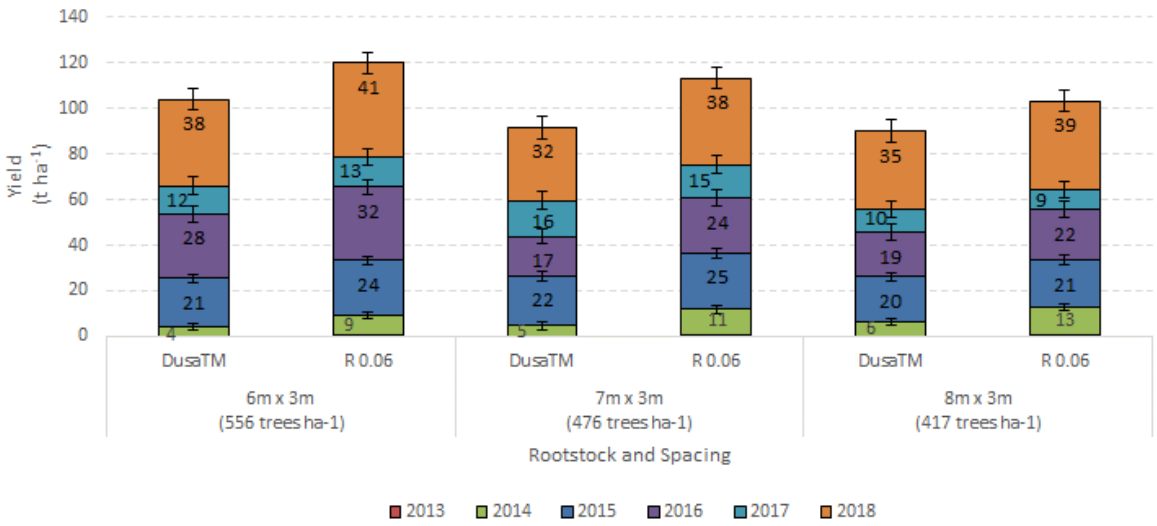

Figure IV. 'Gem®' yield for 3 planting densities (6m x 3m, 7m x 3m and 8m x 3m) and two rootstocks (Dusa™ and R0.06). Data is extrapolated to ton ha^{-1} for each rootstock/density treatment.