

New developments in horticultural research at Westfalia, South Africa

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Abstract

The South African avocado industry is strongly export driven and has just over 12 500 hectares currently devoted to avocado production. Westfalia Fruit Estates (Pty) Ltd is the largest avocado producer in South Africa and Westfalia Marketing SA (Pty) Ltd markets about half of South Africa's total exports. Due to the competition that has arisen in various international avocado markets there has been an increased need for producers and suppliers to remain at the forefront of technological advancements while satisfying consumer preferences. Westfalia recognized this need at its inception and annually invests about USD 1.5 million in research in order to remain a global player. Westfalia has been involved in rootstock screening and evaluation for over 30 years and continue to screen ca. 3000 seedling selections annually. Westfalia's Dusa[®] rootstock is currently the preferred clonal rootstock in both California and South Africa, and is also being tested in other parts of the world. Recently Westfalia have also released two new Hass-like cultivars which are now managed in grower clubs (Carmen-Hass[®] and Gem[®]). These two cultivars not only help to extend the Hass season but also yield well and have good postharvest quality. This paper will highlight the current research projects undertaken by the horticulture team. Specifically, cultivar and rootstock evaluations, non-destructive maturity testing (using near-infrared), and trials related to conditioning avocado fruit to tolerate cold sterilization treatments (i.e. storage temperatures below +1°C).

La industria aguacatera Sudafricana está enfocada fuertemente a la exportación, y a la fecha tiene alrededor de 12 500 hectáreas dedicadas a su cultivo. Westfalia Fruit Estates (Pty) Ltd es el mayor productor en Sudáfrica, y Westfalia Marketing SA (Pty) Ltd comercializa alrededor de la mitad de las exportaciones totales de Sudáfrica. Debido a la creciente competencia en los mercados internacionales, ha habido una creciente necesidad para productores y proveedores de permanecer a la cabeza de los avances tecnológicos mientras que satisfacen las preferencias de los consumidores. Westfalia reconoció esta necesidad en su inicio y ha invertido mucho en fundar su propio departamento de investigaciones en orden de mantenerse como un participante global. Westfalia ha estado involucrado en la investigación y evaluación de portainjertos por más de 30 años y continúa evaluando alrededor de 3000 selecciones anualmente. El portainjerto clonal de Westfalia Dusa[®] es actualmente el preferido en California y en Sudáfrica, y se está probando en distintos lugares del mundo. Recientemente Westfalia también sacó dos nuevas variedades similares a Hass que están siendo manejadas como clubs (Carmen-Hass[®] y Gem[®]). Estas no sólo ayudan a extender la temporada de Hass sino que también producen bien y presentan una buena calidad en post-cosecha. Este artículo hablará de proyectos de investigación que se están llevando a cabo por el equipo de horticultura. Específicamente, evaluaciones de variedades y portainjertos, pruebas de madurez no-destructivas (usando infrarrojo-cercano), y ensayos relacionados a condicionar aguacates a tratamientos de esterilización por frío (i.e. almacenaje a temperaturas bajo +1°C)

Keywords: cultivar, rootstock, postharvest, near infrared, cold sterilization

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Introduction

Westfalia Technological Services (WTS) is the research division of Westfalia Limited, a company within Hans Merensky (HM) Holdings. The strategic aim of WTS is to provide Westfalia with a competitive edge in agro-technology and further to offer technical support for Westfalia's national and international expansions as well as the subtropical fruit industry in general. WTS currently employs seven full time agricultural researchers who focus on various aspects of avocado and mango research. WTS is based on Westfalia Fruit Estate (Limpopo Province), a large scale avocado farm, and avocado research is carried out in close co-operation with Westfalia's production team. Some of the WTS research and development objectives for fresh fruit include: improving fruit yield and quality of export avocados per hectare, extending the production season, and identifying (and licensing) strategic national and/or international partners for exclusive new cultivars. An overview of the most important horticultural research fields will be given.

Fields of Avocado Research

1. Rootstocks

Westfalia started testing, and using, clonal rootstocks as early as the late 1970's. Prior to this the avocado industry in South Africa was based on seedling rootstocks and these offered very little, if any, resistance to *Phytophthora cinnamomi* root rot (PRR). PRR is undoubtedly the most limiting factor to avocado production in South Africa, if not around the world. Today WTS prides itself in being one of the market leaders in the development of clonal avocado rootstocks and is well known, around the world, for their Merensky 2 (Dusa[®]) selection. The South African Avocado industry's tree sales show that currently clonal rootstocks make up 88% of all tree sales in South Africa (W Retief, personal communication, 2010²). Of these Dusa[®] makes up 57% of the sales for the year 2010, with the well known Duke 7 rootstock slowly losing favour. Further over 90% of all trees sales for the last six years from the Westfalia Nursery, the leading South African nursery (in terms of size), have been for clonal rootstocks (primarily Dusa[®]).

Rootstock research requires long term commitment and patience with a new selection taking up to 25 years to be commercially released from the time it is first "selected". While the first clonal rootstocks to be used in South Africa were imported from California WTS also started testing their own selections from the early 1980's. Today WTS's rootstock programme is focussed on improving fruit yield and quality, either directly or indirectly, through the selection of PRR tolerant selections. Seeds are collected from a mother block, consisting of selections which have a history of offering PRR tolerance, germinated and the young seedlings are directly exposed to a PRR inoculum. The most promising "survivors" are then tested a second time in the mistbed before being grafted to Hass and planted in small scale field trials. Once the selections prove not only to be PRR tolerant but also productive they are tested in larger scale field trials and then slowly commercialized. During the pre-commercial trials the "new selection" is tested against the current industry standard and/or other commercially available rootstocks depending on the stage of testing (Table 1). Dusa[®] has been used as WTS's benchmark since 2003. Since the release of Dusa[®] more than 80 promising rootstocks have been identified; some of which are already in the early stages of development (trials planted at the end of 2008). As a leader in rootstock selection and development WTS chooses to collaborate with other highly esteemed rootstock research institutions and our rootstocks are currently not only being tested extensively throughout South Africa but also in several locations internationally (E.g. California, Australia, New Zealand, Chile, and Israel). In return, WTS tests promising new material from our research collaborators under South African conditions.

At Westfalia the use of new generation rootstocks over the last 30 years, which offer more resistance to PRR, has allowed for the decreased use of chemicals, has improved general tree health and uniformity, and therefore has also resulted in higher productivity and profitability. The use of more tolerant clonal rootstocks has also, slightly, improved the longevity of organic orchards where inorganic chemicals, to treat PRR, cannot be used.

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Table 1. Yield data taken over five years at two different geographic locations where Hass on clonal Dusa[®] was compared to other commercially available clonal rootstocks in South Africa.

Trial location	Planting date	Rootstock	Average yield (ton/hectare, 400 trees)					Cumulative Yield (t/ha)	% Yield advantage
			2006	2007	2008	2009	2010		
Mooketsi	2005	Dusa [®]	0	0.85	4.38	9.84	19.74	34.81	81.97
		R0.02*	0	0.47	2.27	3.99	12.40	19.13	
Politsi Valley	2003	Dusa [®]	4.50	5.60	15.77	24.13	20.71	70.71	42.21
		Duke 7	3.54	6.60	10.67	15.05	12.72	48.58	

* Rootstock coded for protection.

2. Cultivars

To ensure competitiveness on the overseas market, testing of new avocado cultivars is of great importance for the future of the South African avocado industry. WTS is constantly on the lookout for cultivars which are similar or better than Hass and the commercial green skin cultivars. Specific traits under evaluation include seasonality, productivity, alternate/biennial bearing, fruit size and postharvest quality. The sensitivity of cultivars to disease is also an important factor. WTS has been testing avocado genetic material from around the world for more than twenty years. It is a long term process, starting with the importation of vegetative material, getting the fruit grafted at the quarantine station, bulking up the material after quarantine and then establishing the material in small scale experimental trials, before going on to larger scale trials, pre-commercial trials and finally commercialization. In total this process can take anything up to 20 years (Table 2).

Table 2. Timescale for the evaluation of new cultivars at Westfalia Technological Services

<i>Procedure</i>	<i>Year</i>
Importation of bud wood (10 - 50 bud sticks)	0
Quarantine (≥ 1 year, 0 - 100% survival rate)	1
Experimental orchard (10 - 20 trees)	5
Large scale testing (50 - 1000 trees)	10
Pre-commercial testing	15
Commercial	20

Carmen[®] (Mendez #1) and Gem[®] (3-29-5) are two promising “Hass-like” avocado cultivars which have been developed in this way (Kremer-Köhne 2002) and are already at the commercialization stage (Bruwer 2007; Bruwer & Van Rooyen 2007). Carmen[®] is very similar to Hass but matures up to four weeks earlier than Hass under South African conditions. To further exploit this, Carmen[®] is being planted in selected geographic areas known for producing early season avocados. Westfalia has exclusive commercial avocado production rights for Carmen[®] in Africa and the Middle East. Gem[®] is our second new “Hass-like” variety. It matures later than Hass, and when planted in traditionally late avocado producing areas, it extends the season by one to two months (three months if fruit are stored). Both cultivars have good postharvest attributes. WTS recently obtained exclusive international rights (from the University of California Riverside) to manage Gem[®]. Widespread testing of both cultivars has been undertaken with commercial expansion occurring through the formation of Grower Clubs. The Grower Club concept is based on managed quantities and quality of fruit of a protected cultivar, sold through controlled channels, in order to maximize returns for the owner, the retailer and the club members (Roe & Brokaw 2007).

New cultivars presently under evaluation at WTS include selections from Chile, Australia, Israel, Mexico and California, and a few local selections.

3. Cold sterilization – Market Access

With the ever growing competition between South Africa and other avocado producing countries for good prices in Europe an interest for accessing new markets has arisen. However, countries such as the U.S.A. require certain mitigation treatments be conducted to eliminate the potential entry of phytosanitary pests into their country. Cold sterilization is one of the treatments that may be regarded as an acceptable treatment for South African fruit flies. However, certain fruit fly species (De Graaf 2009) have been found to be quite cold tolerant (unpublished data) and indications are that pulp temperatures as low as 2°C may be required (for 20 days) to meet phytosanitary requirements (USDA-APHIS treatment manual, T107 - a Cold treatment). WTS researchers have been involved in finding the best postharvest treatments for Hass avocados that are destined for a cold sterilization treatment since 2008 (Van Rooyen 2009; Van Rooyen & Bezuidenhout 2010). This research has included looking into export container modifications, “pre-conditioning” treatments while at the same time determining the changes in chilling sensitivity of fruit throughout the season.

4. Non-destructive quality assessment

There has recently been much discussion about the need for non-destructive measurement of fruit quality to improve product quality and homogeneity. Near-infrared spectroscopy (NIR) is arguably the most suitable technology for this purpose as it offers the rapid non-destructive measurement of various parameters of organic material (Nicolai, Beullens, Bobleyn, Peirs, Saeys, Theron & Lammertyn 2007). However, the instrumentation must be calibrated to be of use. It requires a number of seasons’ and production locations’ data to develop robust models so that the predicted values of future fruit are accurate (Peirs, Tirry, Verlinden, Darius, & Nicolai 2002).

Only recently has research been conducted on the use of NIR in the avocado industry (Wedding, White, Grauf, Wright, Tilse, Hofman, & Gadek 2011). WTS is expanding the use of NIR in the avocado industry by examining various NIR instruments for the measurement of non-conventional parameters; as such we are currently developing models to: predict days to ripen, detect frost-damaged fruit, and determine the risk of mesocarp discolouration on the packline to ensure that class one fruit have both a high external and internal quality. Most of these parameters are being evaluated on an online NIR instrument. WTS is also calibrating handheld NIR to measure maturity (moisture content) for tracking maturity pre-harvest and performing spot checks postharvest to ensure fruit are legally mature and will ripen fully. WTS is also trying to assist avocado processing plants with using NIR to detect whether their final products are devoid of any foreign matter.

5. General avocado research

Avocados are horticulturally speaking still considered to be a young crop with considerable room for improvements with regard to orchard practices. The advances in agro-technology and international collaboration also afford researchers/growers the opportunity to continuously improve their approach to avocado production and postharvest handling. The WTS horticulture team thus remain involved in various trials regarding fertilisation, pruning, tree management and more recently in addressing the challenges of high density orchards (1000 trees/hectare).

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