Field assessment of avocado rootstock selections for resistance to Phytophthora root rot

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Abstract

The use of *Phytophthora cinnamomi* (Pc) resistant rootstocks has become an increasingly useful tool in the integrated management of Phytophthora root rot (PRR) in avocado orchards. Field trials have been conducted at three locations in the eastern production areas of Australia since December 2005 in replant land with a history of PRR to assess the performance of rootstock selections. Seedling and clonally-propagated rootstocks were included from a range of currently used rootstocks as well as material selected from trees which had survived for many years despite high Pc pressure, ie. “escape” trees. All rootstocks were grafted with ‘Hass’ scions.

New selections ‘SHSR-02’, SHSR-04’, ungrafted ‘Hass’ (rooted cuttings from clonal propagation) and the commercially available rootstock ‘Dusa™’ were found to be consistently better survivors and healthier over time compared to other rootstocks including ‘Reed’, ‘Velvick’ and ‘A10’. Superior health was often associated with increased tree height and trunk girth. ‘Reed’ was consistently highly susceptible, and had the lowest yields at a site with relatively low PRR pressure where tree health of ‘Reed’ only was compromised by Pc. Soil baiting and root isolations confirmed the presence and infectivity of Pc in soils at the field sites. The trials clearly demonstrated the advantage of using rootstocks able to withstand high *Pc* pressure when establishing new avocado orchards, particularly in replant land.

EVALUACIÓN DE CAMPO EN PIES DE INJERTO DE AGUACATES SELECCIONADOS PARA LA RESISTENCIA A LA PUDRICIÓN DE RAÍZ POR PHYTOPHTHORA

El uso de pies de injerto, en cultivos de aguacate, resistentes a *Phytophthora cinnamomi* (Pc) se ha convertido en una herramienta útil para el manejo integrado de la pudrición de raíz por *Phytophthora* (PRR). Para evaluar el comportamiento de los pies de injerto seleccionados, se realizaron trabajos de campo en tres lugares del Este de Australia desde 2005 en tierras replantadas en donde se había reportado la presencia de PRR. Para ello se incluyeron pies de injerto propagados por semilla o clonados como también material seleccionado de árboles los cuales han sobrevivido muchos años a pesar de la alta presión ocasionada por Pc, por ejemplo ‘escape’. Todos los pies de injerto fueron injertados con vástagos de ‘Hass’.

Se encontró que nuevas variedades de ‘Hass’ no injertadas (esquejes enraizados por propagación clonal), ‘SHSR-02’ y ‘SHSR-04’, sobrevivieron y fueron más sanos que otros pies de injerto incluyendo ‘Reed’, ‘Velvick’ y ‘A10’. La salud es asociada con el aumento de la altura y grosor del tronco del árbol. ‘Reed’ es altamente susceptible y el rendimiento más bajo en lugares de baja presión ocasionada por PRR en donde la salud de ‘Reed’ solo era comprometida por Pc. Muestras de suelo y raíces aisladas confirma la presencia e infección por Pc. Los ensayos demostraron claramente la ventaja al establecer nuevos cultivos de aguacate, especialmente en tierras replantadas, al utilizar aquellos pies de injerto que pueden soportar altas presiones ocasionadas por Pc.

Introduction

Phytophthora root rot (PRR), caused by the oomycete pathogen *Phytophthora cinnamomi* (Pc) is ubiquitous within avocado production areas in Australia and overseas, and is considered the most destructive and important disease. Its impact is currently reduced using an integrated approach including cultural (mulching, adequate drainage and optimal nutrition), chemical (potassium phosphonate) and genetic approaches (breeding and selection of resistant or tolerant rootstocks). Recent selections, identified and developed from trees which have survived for some years in the presence of Pc, have been included in field trials at three sites, known to have high Pc populations. Their growth and survival was monitored over time, since planting in late 2005 and early 2006. The majority of this work has recently been published (Smith *et al.* 2011) and the reader is referred to the publication for full details.

Materials and Methods

All details of field trials conducted to assess establishment, survival and performance of a range of rootstock material are described in a recent publication of this work, and will not be repeated in detail here. See paper by (Smith *et al.* 2011). Very briefly, 3 sites were chosen on commercial avocado orchards which had a history of severe Phytophthora root rot in trees prior to bulldozing the block. The sites were at Duranbah, northern NSW, Hampton, south-east Queensland and Childers, central Queensland. Several trees of each rootstock (with 'Hass' scions) were planted at each site. Trees were sourced from our collaborator, Dr Tony Whiley, and also from Anderson's Nursery and Birdwood Nursery. Rootstocks included those recovered from 'escape' trees, that is, those which have survived for long periods despite high *P. cinnamomi* pressure. Trees were treated with phosphonate and metalaxyl for the establishment period, to allow vigorous growth and favourable root:shoot ratio such that they had the opportunity to express resistance once Pc protection measures were discontinued. Trees were assessed regularly for canopy health, on a 0 to 10 scale (Darvas *et al.* 1984), and fruit yields (weight and pieces of fruit per tree) were collected in 2009 and 2010.

Results and discussion

Full details of this work are available in Smith et al, 2011, and for copyright reasons, will not be duplicated here. Briefly, two selections 'SHSR-02' and 'SHSR-04', as well as ungrafted 'Hass' and the commercial rootstock 'Dusa™' were significantly better survivors and were healthier over time than other rootstocks including 'Velvick' (from various sources), 'Duke 7', A8, A10, 'Reed', 'Latas™', 'Rigato' and 'Barr Duke'. 'Reed' was consistently highly susceptible and most of these trees had died within the 4 year assessment period. Superior tree health was often associated with increased tree height and trunk girths (Smith *et al.* 2011). The study demonstrated variation in establishment of trees under high disease pressure, for example at the Duranbah, NSW site (Plate 1), tree health after 2 years ranged from 2.7 to 8.5, (on a scale where 10 = dead), compared with under a lower disease pressure at the Childers QLD site 3 years after planting where tree health ranged from 0 (healthy) to 2.2. In other words, trees thrived under lower Pc pressure at Childers in the first 3 years of the trial.

More recent data on health of trees in the Childers trial, and fruit yields, is presented in Table 1 (not included in above mentioned publication). At 4 and 4.5 years after planting, the effects of Phytophthora root rot were becoming more apparent, with trees on 'Reed' rootstock scoring an average of 6.7 and 6, respectively (compared to a maximum of 2.2 in previous years). Trees on 'Reed' rootstock were significantly less healthy than all others except 'Velvick' seedling (Anderson) at both assessment times, and 'A8' and 'A10' assessed 4.5 years after planting (Table 1). The healthiest trees were on 'Dusa' and 'Latas' rootstock. Despite having the healthiest canopies, 'Dusa' and 'Latas' were not the highest yielding rootstocks in 2010, having yields of 80% and 88% those of the highest yielding rootstock 'Velvick' seedling (Simpson). 'Reed' rootstock yielded very poorly, with only 30% the weight of fruit compared to 'Velvick' seedling (Simpson). This poor performance could be due to its relative ill thrift, and known high susceptibility to PRR. Root examination, selective isolation of roots on selective media and lupin baiting for Phytophthora confirmed an extremely high population of *P. cinnamomi* at all trial sites

Rootstock selections with increased establishment and survival capability under high Phytophthora root rot (PRR) disease pressure have been identified in this project. Selections 'SHSR-02', 'SHSR-04', ungrafted 'Hass' (rooted cuttings from clonal propagation), and the commercial rootstock 'Dusa™' were significantly healthier over time than other rootstocks, including many commercially grown such as 'Reed', 'Velvick' and 'Duke 7'. There is very little evidence for the source and/or mechanisms of the observed tolerance, and further research on the G x E (genotype x environment) interactions, root regeneration capacity, biochemical and/or genetic markers (as discussed in (Smith, Dann *et al.* 2011) is necessary. Also of interest in the current study was the superior performance of ungrafted 'Hass' in one trial (results not presented here), and raises the question about whether grafting in some situations may exacerbate either root or canopy/fruit diseases, due to potential physiological stress imposed. This issue will be investigated further.

Plate 1 Rootstock trial at Duranbah, NSW, demonstrating healthy tree on 'SHSR-04' selection among less thrifty trees

Table 1 Average health and yield of trees grafted to different rootstocks in the Childers trial, established in May 2006

Rootstock	Tree health at 4 years		Tree health at 4.5 years		Crop Weight per tree (kg)		Pieces of Fruit/tree	
Velvick seedling (Lynwood)	3.8	bcd	3.0	bcd	80.0	a	329	a
Latas™ clonal	2.7	cd	2.5	cd	70.4	ab	268	ab
A8 seedling	3.9	bcd	4.1	abc	68.2	ab	289	ab
Dusa™ clonal	2.4	d	1.2	d	64.7	ab	240	abc
A10 seedling	4.3	bc	4.2	abc	56.9	abc	250	abc
Velvick seedling (Anderson)	5.1	ab	4.9	ab	46.3	bcd	191	bcd
Velvick clonal (Whiley)	4.9	b	3.8	bc	35.2	cd	144	cd
Reed seedling	6.7	a	6.0	a	23.9	d	97	d

Average tree (canopy) health ratings were assessed using a rating scale of 0-10, where 0 = healthy and 10 = dead, at approx. 4 and 4.5 years after planting. Yield parameters assessed 4 years after planting.
Mean values within columns followed by the same letter are not significantly different at P = 0.05.

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