

Rootstock Status of Countries Visited

California

The Californian industry developed largely on seedling 'Topa Topa' (Mexican) and to a lesser extent 'Mexicola' (Mexican) and 'Lula' (Guatemalan/West Indian) rootstocks. 'Topa Topa' and 'Mexicola' left a legacy of rootstocks highly susceptible to *Phytophthora* root rot while 'Lula' gave significant rootstock/scion incompatibility as seen in the plantings of the Rancho California development near Temecula.

In more recent times the industry has produced trees on cloned rootstocks of which 'Duke 7' has been the main one used. New lines such as 'Thomas' and 'Merensky 2' are being introduced to the industry as clones however, there is still a significant percentage of trees still propagated on seedling 'Topa Topa'.

Rootstock breeding programme

Dr John Menge, University of California Riverside, has a rootstock breeding programme aimed at producing rootstocks with greater tolerance to *Phytophthora* root rot than material currently available to industry. To facilitate this programme rootstock lines with proven *Phytophthora* tolerance have been planted in isolation to reduce the risk of introduction of foreign pollen. Crosses being made are UC2001 (seedling 'Duke 7'), 'D9' (an irradiated seedling of 'Duke 7'), 'Thomas', and 'Spencer' ('Spencer' looks like 'Sharwil' but has high anise level in the leaves - grows with a crawling habit exhibiting loss of apical dominance. Growth habit may be due to greater sensitivity to boron deficiency). In a second breeding plot 'Spencer', 'Toro Canyon', 'PP4' ('Zentmyer') and 'Thomas' are planted. To date the greatest number of seedlings with *Phytophthora* root rot tolerance has come from 'Thomas' where it is used as the maternal source. Cross pollination is encouraged by netting trees and introducing bees to the enclosure (Fig. 24). Where netting is not used the breeding plots are at distance from other avocado trees so as to prevent the introduction of other pollen.



Fig. 24 Caged trees in the California *Phytophthora* tolerant rootstock breeding programme.

For root rot evaluation seeds are collected from the various maternal sources, germinated in shallow boxes in a vermiculite rooting media and inoculated with *Phytophthora cinnamomi*. Roots are examined for decay and then the best survivors potted on into larger pots where they are re-challenged with *Phytophthora cinnamomi*.

The survivors showing promise are then taken into the field and grown on to produce propagation material for cloning trials where the candidate rootstock is grafted to ‘Hass’. The Menge rootstock breeding program is using “Brokaw” technique developed for ‘Duke 7’ with a clear plastic sleeve so that rooting can be monitored. ‘Topa Topa’ is used as the “nurse seed”. It has been found that some seedlings are quite difficult to clone using the ‘Duke 7’ protocol. This result is consistent with similar comments made by other nurseries visited that were cloning other rootstocks of interest.

Florida

The Florida avocado industry is based on seedling rootstocks with ‘Waldin’ the most commonly used. ‘Lula’ has also been used to a lesser extent. There is no data available to support the choice of ‘Waldin’ as a rootstock and it seems that its use is largely through convenience (fresh seed available at the beginning of the nursery production cycle), availability of large numbers of seeds and easy to work with in the nursery.

New Zealand

The New Zealand industry is seedling rootstock based with ‘Zutano’ the predominate rootstock used. According to the genealogical relationships among cultivated avocado as determined by RFLP analysis ‘Zutano’ is a Mexican/Guatemalan hybrid but most closely related to the Mexican race (Davis *et al.*, 1998). Examination of orchards revealed a significant percentage of rootstocks showing an appreciable overgrowth of the scion (Fig. 25).



Fig. 25 ‘Hass’ grafted to ‘Zutano’ seedling rootstock at Sweetwater, Kaitaia. Note the strong overgrowth of the scion.

It was also observed that many of the fruiting ‘Hass’ trees had cropped on limbs that had not re-foliated during the summer. It is suspected that these trees would have badly defoliated during flowering which is usually what happens when the degree of overgrowth shown in Fig. 25 is present.

No reason could be given for the use of seedling ‘Zutano’ by the New Zealand industry but it is most likely due to that of availability and ease of

production of nursery trees.

‘Hass’ have also been grafted to seedling ‘Reed’ and planted in some orchards. Grower comment was that they believed the ‘Hass’/‘Reed’ combination was more productive than the ‘Hass’/‘Zutano’ combination but no reliable records were available.

New Zealand soils are highly leached and deficient in boron hence this nutrient must be carefully managed. Boron uptake and translocation to the top of the tree is difficult where 'Zutano' is used as a rootstock thus reflecting its Mexican inheritance. On the other hand where 'Reed' has been used as a rootstock grafted to 'Hass' boron uptake is significantly more efficient and growers unaware of the differences have had phytotoxicity problems where they have treated both rootstocks at the rate required to raise levels in trees with seedling 'Zutano' rootstocks. This result clearly shows the necessity of knowing the parentage of rootstocks used and managing their nutrition in an appropriate manner. The fact that 'Zutano' is responding similarly to 'Duke 6' and 'Duke 7' rootstocks with respect to boron uptake might also imply that other nutrients are similarly effected and therefore this combination may also be having a negative impact on postharvest fruit quality.

Elite performing 'Hass' trees were inspected at Ron Bailey's property at Te Puke where it was claimed that trees were grafted to seedling 'Fuerte'. However, the trees showed no sign of incompatibility at the graft union which almost always occurs when this combination is used.

South Africa

Through to the mid-1980's the South Africa avocado industry was widely planted on seedling 'Edranol' rootstocks. With the development of 'Duke 7' as a Phytophthora-tolerant rootstock the industry swung strongly across to cloning this rootstock along with 'Martin Grande' (the G755 series). In good soils 'Marin Grande' was soon abandoned due to high vigour and poor cropping however, it still has a role in heavy, wet soils where vigour is limited and yields improve (*Note: a similar experience with this 'Marin Grande' has been reported from Western Australia and the rootstock should be re-evaluated under these conditions*). It is worth noting that in the Phytophthora rootstock evaluation block at Westfalia Estates 'Edranol' cloned as a rootstock and grafted to 'Hass' is a highly susceptible rootstock with most trees dying in the first 18 months after planting.



Fig. 26 Phytophthora trunk canker in a 'Duke 7' rootstock in South Africa.

'Duke 7' is still the mostly widely cloned rootstock used in South Africa but is susceptible to Phytophthora trunk canker (Fig. 26) and due to its Mexican origin has difficulty in translocating boron to the scion variety.

Rootstock breeding programme

Merensky Technological Services has a rootstock breeding programme aimed at producing lines with greater Phytophthora root rot tolerance and is run on similar lines to the Californian

(Menge) programme. A mother seed block has been established in isolation and includes 'Duke 7', 'Thomas' and 'Merensky 1' and 'Merensky 2'. These latter two rootstocks were recovered as escape trees from orchards severely affected by root rot. The mother seed block has trees of the breeding lines planted in close proximity that produce seeds via open pollination. About 3000 seeds are produced each year and these are germinated in vermiculite and challenged with *Phytophthora cinnamomi*. It is normal to get only two new candidates each year to take forward for further field testing.

Note: both the Californian and South African Phytophthora root rot tolerant breeding programmes are based on Mexican race lines. Research in subtropical Australia to date indicates that when Mexican race rootstocks are grafted to 'Hass' there is deterioration in postharvest fruit quality (e.g. 'Duke 6', 'Duke 7' and 'PI'. As the results have been sourced from a limited population it is too early to know if all Mexican race rootstocks will give this result but sufficient evidence is available (Willingham et al. 2001; Marques et al. 2002) to suggest that new Mexican race rootstocks be tested thoroughly for all production aspects prior to release to industry.

The Merensky Technological Services rootstock improvement programme is also recovering rootstocks from high-yielding trees for cloning and re-evaluating performance when grafted to 'Hass' (Fig. 27).



Fig. 27 A consistently high-producing tree identified at Westfalia Estates. Rootstock recovery is proceeding via inducing rootstock sprouting from wounds made below the graft union.

References

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