Proceedings V World Avocado Congress (Actas V Congreso Mundial del Aguacate) 2003. pp. 171-175.

HORTICULTURAL CHARACTERISTICS OF HASS AVOCADO ON COMMERCIAL CLONAL AND SEEDLING ROOTSTOCKS IN CALIFORNIA

Larry S. Rose

Brokaw Nursery, Inc. 1419 Lirio Avenue, Saticoy, California 93007, USA
E-mail: larry@brokawnursery.com

SUMMARY

Long-term commercial use of clonal rootstocks has confirmed many benefits but also exposed shortcomings of various cultivars. Clonal rootstock selection has expanded to include analysis of multiple traits of soil stress factors and productivity. The quality of new introductions is potentially greatly improved. Acceptance of new commercial clonal rootstocks now requires higher production and well rounded adaptability.

INTRODUCTION

Clonal avocado rootstocks have been commercially planted in California since 1977. By 1981 clonal rootstocks predominated commercial plantings. Through the 1990s, 95% of trees sold by Brokaw Nursery were on clonal rootstocks. In spite of a 50% price premium of clonal trees versus trees on Mexican seedling rootstocks, avocado growers recognized the potential of various clonal rootstocks for greater productivity, uniformity and benefits of adaptability to soil stress factors. During this current boom of avocado planting in California, nurseries are supplying trees for at least 3,500 new acres per year, with clonal trees representing approximately 75% of that market.

Growing avocados in arid Southern California is never as simple as dealing with a single stress factor. Typically *Phytophthora cinnamomi* infested soils can lack important aeration due to finely textured soils, poor soil structure or impervious layers in the soil profile. Heavy winter rains on cold soils can compound the problems of soil saturation and root asphyxiation. Faced with these factors rootstock selection has generally been limited to Mexican race cultivars due to their adaptability to poor aeration and cold winter temperatures. However, Mexican rootstocks are generally highly sensitive to chloride and sodium toxicity thereby complicating planting choices where poor drainage precludes leaching of salts. Although initial clonal rootstocks were selected for tolerance

to *Phytophthora cinnamomi*, they also demonstrated consistent growth and canopy uniformity. In addition to tolerance of *P. cinnamomi*, some cultivars also possess resistance to other fungal diseases, reduced absorption of salts and resistance to lime-induced chlorosis. Most importantly, select clonal rootstocks have greater fruit productivity when grafted to the Hass fruiting cultivar.

Over the years, the formal research and screening of potential commercial rootstocks in California has been broadened from its focus on *P. cinnamomi* to include tolerance to other diseases, salinity, tree size, productivity and a tendency to begin bearing early in the life of the tree. However, field experience with trees on clonal rootstocks ultimately defines the range of tolerance to soil stress factors inherent in various cultivars, their benefits and limitations. No commercial clonal rootstock today is perfect for all situations but since clonal rootstocks have come to dominate orchard plantings in California, growers and nurseries alike have come to a better understanding of custom-selection of the best rootstock cultivar for each situation.

UNDERSTANDING CLONAL ROOTSTOCK WEAKNESSES

Duke 7, the first commercially available clonal rootstock in California is a Mexican selection made by Zentmyer over 50 years ago. The Duke 7 has had a checkered history. Assumptions made about the performance of clonal rootstocks in general were inaccurately attributed to this premier cultivar when planted in severe locations and given normal care. Many failures of Hass on Duke 7 were attributed to the rootstock cultivar itself while specific sensitivities of all clonal rootstocks were generally unknown (Coffey 1987).

Clonally rooted cuttings have no central tap root and grow from a crown of roots originating from a relatively short stem close to the surface of the soil. Trees grown by this method are very sensitive to abusive irrigation and are quick to dry out especially during the establishment phase of the tree often leading to the loss of the tree. Stressed plants have less resilience and disease resistance. Once clonal plants are weakened and are unable to refoliate, roots die quickly and tree death is predictable. A poorly established clonal rootstock of any cultivar has great difficulty wintering over the first year. When stressed by cold winds and exposed to heavy rains, loss of roots causes a rapid defoliation when mature leaves are shed in the early spring. One-year-old defoliated clonally rooted trees rarely recover, however, once past the establishment phase, clonal trees are more resilient to environmental stress. Seedling rooted trees, though variable by nature, are not as prone to death following defoliation, but seedling trees do not possess consistent, positive traits replicated by clonal rooting.

Early commercial use of clonal root rot resistant trees were often planted in low, wet swales or in spots of poor soil quality where original trees had failed. When normal irrigations were applied to these areas along with existing, older trees, the less resilient clonals often died. Other factors such as constant influx of *P. cinnamomi* contributed to poor performance, but even without *Phytophthora* pressure clonal trees needed meticulous care to become established in compromised conditions. As years passed and new cultivars were tried, growers were further along the learning curve and applied new techniques with better success. Their success was often attributed to the newer cultivar and less so to better farming practices. It is now the norm to utilize integrated management practices (Coffey 1988) of remedial site preparation, cultivar selection, generous mulching, gypsum topdressing, fungicides and irrigation monitoring to assure replant success (Menge, 1991). Success rate of clonals planted in non-infested soils exceed that of trees on seedling rootstocks.

Duke 7

Duke 7 has a tendency to remain greener in cool winter soils when chlorosis is at its worst and begins to grow early in the spring before trees on other rootstocks. Hass on Duke 7 bears early in its life, bears large fruit and lots of it (Arpaia et al 1993). Duke 7 has only moderate root rot tolerance but its horticultural adaptation is broad and its salt tolerance is strong for a Mexican rootstock (Oster et al 1992). It still remains a preferred variety where *P. cinnamomi* is not an imminent threat.

Toro Canyon

Although Toro Canyon is a comparable producer to Topa Topa in soils not infested with *P. cinnamomi*, its moderate size provides for very efficient production for its canopy volume. Because it is significantly more resistant to root rot than Duke 7 and more tolerant to salts than Mexican seedlings, it has become the major commercial clonal selection. It demonstrates very good sodium exclusion and chloride tolerance for a Mexican rootstock (Mickelbart et al 2002). Toro Canyon's timing on the scene coincided with the introduction of integrated control of *P. cinnamomi* and overall better understanding of how to grow clonal rootstocks in difficult situations. Toro Canyon has significant resistance to *P. citricola* infection and canker.

Borchard

Borchard rootstock, a Mexican selection from southern California, is resistant to lime-induced iron chlorosis, a tendency in calcareous soils prevalent in coastal groves. Were it not for the lack of root rot resistance Borchard would be a major commercial variety having production 25% higher than Topa Topa (Arapia et al 1993). As it is, it remains a significant problem-solving rootstock in moderate to highly calcareous soils. Borchard is resistant to *P. citrocola* canker (El-Hamalawai et al 1991).

Thomas

Thomas was initially very impressive, being one of the best rootstocks for root rot tolerance. Its popularity and use has waned as its shortcomings became more apparent. Thomas is very susceptible to both *P. citricola* and *Dothiorella gregaria* canker, a problem with cultivars of Guatemalan race. This vigorous rootstock is highly sensitive to salinity and is a poor producer in many locations. It remains useful in severe root rot areas where salinity is not an issue.

G755

Three selections of the G755 debuted in the 1980's as the ultimate rootstocks and nearly swept aside predecessor rootstocks. These *Persea schideiana* x *P. americana* hybrids passed preliminary root rot screening in the field but later showed poor adaptability especially in calcareous soils. Fruit production trials ultimately ended their use when they showed poorly (Arpaia et al 1993). Some later limited reports of adequate production were too late to revive interest. The G755's best contribution to the California avocado industry was a stark reminder that root rot resistance is only part of the path to greater productivity.

WHAT LIES AHEAD

The bar has been raised and the standard for commercial release is higher than in the past. Duke 6, G6, Barr Duke, D9 and others are worthwhile root rot tolerant rootstocks but do not possess the collection of positive traits that can attract interest to become commercially important. Grower's general satisfaction with current rootstocks preclude introduction of mediocre candidates. Rootstocks now in trial from promising outcrosses and isolated survivor trees must have superior production and traits of tolerance to many soil stress factors to be contenders for commercial use.

West Indian Race

West Indian rootstocks have, in the past, not performed satisfactorily due to poor root growth, late leaf development in the spring, generally pale color and lower production than trees on Mexican race rootstocks. Seedlings of Lula, a West Indian hybrid, have been used by nurserymen for their vigor and ease of production but have no other outstanding characteristics. Significant decline occurred from trees planted on West Indian seedling rootstocks in the 1970s (Ellstrand 1992). Now, a resurgence of research is currently being done with this salt tolerant group. Selections from Ben-Ya'acov's rootstock work are being screened for root rot resistance, salt tolerance and productivity in California. Hopes are that some clonals may adapt to California's worsening water quality, but at this point West Indian clonal rootstocks are not utilized in California.

Merensky 2 (Dusa)

With only 4 years of trials in California the Merensky 2, or Dusa rootstock as it was called, has drawn a lot of attention. Not only has it fared well in widespread replant field trials throughout California, preliminary results with salinity screening show it may be a well rounded rootstock. What is driving anticipation are reports from South Africa that Hass is up to 30% more productive on Merensky 2 than on Duke 7 (Roe et al 1999). This year more than 7,000 trees were planted in California and demand is strong even in the face of limited experience under California conditions. Time will tell.

REFERENCES

ARPAIA ML, BENDER, GS, WITNEY GW 1993 Avocado clonal rootstock production trial. Calif. Avocado Soc. Yrbk. 77: 89-93Ben_Ya'acov A, Michelson E.1995. Avocado rootstocks. Horticultural Reviews 17: 381_429

BENDER GS, ARPAIA ML, WITNEY GW 1991. Increasing production of avocados... the potential is there. California Grower, December: 28-29

BERGH BO 1967 Reasons for low yields of avocado. Calif. Avocado Soc. Yrbk. 51:161-172.

BROKAW WH 1982 Clonal rootstocks: personal observations and a peek into the future. California Avocado Society Yearbook 66: 81-92

BROKAW WH 1982 Field experiences with clonal rootstocks. S. A. Avocado Growers' Assoc. Yrb. 10: 34-36.

COFFEY MD 1987 A took at current avocado rootstocks. California grower 11(4):15-17

ELLSTRAND NC, CLEGG JA, ARPAIA ML, WITNEY GW 1992, A Genetic Basis for Avocado Decline in The Rancho California Area of California. Proc. of. Second World. Avocado Congress 1992 p. 575

EL-HAMALAWI ZA, MENGE JA, GUILLEMET FB, 1991 Comparison of Resistance to Phytophthora citricola in Nineteen Avocado Rootstocks under Greenhouse Conditions. California Avocado Society 1991 Yearbook 78:121-12

MENGE JA, GUILEMET FB, CAMPBELL S, JOHNSON E, & POND E 1991 The performance of rootstocks tolerant to root rot caused by Phytophthora cinnamomi under field conditions in southern California. Proceedings of the Second World Avocado Congress, Vol. I.

MENGE JA 1998 Screening and evaluation of new rootstocks with resistance to Phytophthora cinnamomi. Proceedings: California Avocado Symposium, Spring 1998: 41-43.

MICKELBART MV, ARPAIA ML, 2002. Effects of salinity on growth, ion concentrations and water relations of 'Hass' avocado (Persea americana L.) trees propagated on three rootstocks. J. Am. Soc. Hort. Sci.

OSTER JD, ARPAIA ML 1992 'Hass' Avocado Response to Salinity as Influenced by Clonal Rootstocks. Proc. of Second World Avocado Congress 1992 pp. 209-214.

ROE DJ, MORUDU TM, KÖHNE JS 1999 Performance Of Commercially Grown 'Hass' Avocado On Clonal Rootstocks At Westfalia Estate, South Africa. Revista Chapingo Serie Horticultura 5: 35-38

ZENTMYER GA 1980. Phytophthora cinnamomi and the disease it causes. Phytopathol. Monogr. 10. Am. Phytopathol. Soc., St. Paul, MN, USA.