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PROGRESS IN ROOTSTOCK RESEARCH IN CALIFORNIA

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OPSOMMING

Seden die eerste avokado onderstam wat verdraagsaam teenoor wortelvrot is. Duke 7, verskyn het in 1975, is ander vrygestel en nuwe en belowende onderstamme, insluitend Thomas, Barr Duke, D9 en G1033 ondergaan tans evaluaste in die veld. Kiemplasma is verkry uit versamelings in Sentraal Amerika, versamelings van "ontsnapte borne" in boorde in Kalifornië, Australië en Suid-Afrika, en van saailinge wat verkry is deur kruising van besondere ouers. Hoewel onderstamme wat uit al hierdie borne verkry is belowende mates van verdraagsaamheid getoon het, het die resultate 'n nuwe belangstelling in teling aangewakker. Nuwe en belowende onderstam materiaal word nou evalueer deur middel van die komponent-analiese tegniek om die aard van hulle verdraagsaamheid teen oor ***Phytophthora cinnamomi*** *te bepaal, en ook onderveldtoestande. Hoewel nuwe onderstamme on geënt evalueer is, isditgevinddat die onderstamme beterpresteer as wanneer hullegeënt is. Nuwe proewe, waarby honderde borne wat op die nuwe sowel as ouer onderstamme geënt is, is in 1984 geplant in veld proewe in al die verskillende grond en klimaatsomstandighede van die produksie gebied van Kalifornieë. Die volgende 5-10 jaar behoort groot veranderings in die gebied van onderstam navorsing op te lewer.*

SUMMARY

Since the first root rot tolerant rootstock, Duke 7, became available in 1975, others have been released and new and promising rootstocks, including Thomas, Barr Duke, D9 and G1033, are currently undergoing field evaluation. Germplasm was obtained from collections in Central America, collections from rootstocks of escape trees in orchards in California, Australia and South Africa, and seedlings produced by crossing specific parents. Although rootstocks from all these sources have shown promising degrees of tolerance, new interest in breeding for tolerance has been generated by results obtained to date. New and promising rootstock material is being evaluated by the component analysis technique, to determine the nature of tolerance to Phytophthora cinnamomi, under field conditions. Although new rootstocks had been evaluated in the ungrafted condition, it was found that such rootstocks performed better than their grafted counterparts. New trials involving hundreds of trees grafted on different new and older rootstock selections were planted in field trials distributed throughout the entire range of soil and climatic conditions of the production area of California in 1984. The next 5-10 years should see major progress in the field of rootstock research.

INTRODUCTION

In 1975 the first commercial tolerant clonal rootstocks of Duke 7 became available in California. Since that time about a half million trees have been sold, mainly with Hass scions. Smaller numbers of G6 clonal rootstock have also been sold. Recently (October 1984) a third rootstock G755 was released by the University of California and the first commercially-available trees will be on sale in California by spring 1 985. Currently under field evaluation a re other tolerant rootstocks of which the most promising include Thomas, Barr Duke, D9, and G1033.

Germplasm sources

Our sources of tolerance to *Phytophthora cinnamomi* are threefold:

i) collections made in Central America, especially Guatemala;

ii) collections made in California, Australia, and South Africa from the rootstocks of "escape" trees; and ¡ii) seedling selections, some produced by crossing specific parents (e.g., G6 X Duke 7).

All three sources of root rot tolerance have produced promising rootstocks and at the present time all are being exploited. The use of plant breeding in this venture is still ¡n its infancy. Until recently this approach was severely hampered by the paucity of suitable breeding partners. In addition, plants breeding at UCR had concentrated mainly on producing new cultivars. However, the supremacy of Hass in the U.S. marketplace, and the current availability of many experimental rootstocks, is stimulating new interest in rootstock breeding. In California, we currently screen several thousand seedlings annually for tolerance performance. In fact, in the last three years most of our more promising selections have been made using material from Dr Bergh's breeding program.

Component analysis

Aside from the primary screening program, we have two further dimensions to our rootstock research: i) component analysis of the basis of tolerance, and ii) large-scale field evaluation of new rootstocks.

The expression of tolerance in these rootstocks is likely to be very complex. Component analysis is an approach to evaluation of resistance developed by research workers studying general resistance to potato late blight caused by *Phytophthora infestans* (Umaerus *et al.,* 1983). In our own work, we have used container-grown clonal rootstocks, especially G6, Duke 7, G755 and G1033. Results of a study with G6and Duke 7 indicated that both rootstocks, and especially Duke 7, supported high populations of *P. cinnamomi* (Kellam & Coffey, 1984). Despite this high level of disease there was a high proportion of living roots present after 20 weeks compared to a susceptible seedling rootstock. Severe root pruning produced a rapid regrowth of Duke 7 and G6, but not of two different susceptible seedling rootstocks Topa-Topa and Walter Hole (Kellam & Coffey, 1984).

Recently, we have compared G755C, G1033 and Duke 7 for their resistance to

pathogen invasion. Of the three, G755C was the most resistant (Dolan & Coffey, 1984) in tests using either bare-rooted clonal material previously grown in a vermiculite medium on detached etiolated stems similar to those produced in the clonal propagation method of Froehlich & Platt (1972). G1033 was intermediate in its resistance (Dolan & Coffey, 1984). Detached roots of G755C were as susceptible to pathogen invasion as those of Duke 7.

Evaluation of Rootstocks

In the final context, component analysis should be conducted with field-grown trees using rootstocks bearing a commercial scion such as Hass. Such research has proven fruitless in the past because suitable plantings containing these new rootstocks in a replicated design have not been available. However, this year several large plantings were made.

There is a remarkable paucity of field data available on rootstock performance. With Duke 7 several thousand of these were planted in experimental plots, however, most of these were in an ungrafted state. There was no accurate compilation made of rootstock performance. However, it was clear that Duke 7 merely by its survival in appreciable numbers was superior to a seedling rootstock such as Topa-Topa.

In recent years the rootstock G6 has also been introduced. However, no valid comparison has been made of its performance relative to Duke 7 using rootstocks with Hass scions. With the accumulation of a new generation of rootstocks such as G755, Barr Duke and Thomas it has become increasingly important to begin large scale field trials.

Initially, new rootstocks had been evaluated in an ungrafted condition. This was useful since it served the dual function of providing abundant budwood should the selection be effective. Using this method, G755 (selections A, B and C), Thomas, D9, Barr Duke and G1033 have shown high tolerance to avocado root rot. However, such evaluations may not accurately reflect performance in a grafted condition. In Table 1, the performance of ungrafted G755B ana particularly ungrafted G755C was superior to the grafted selection.

In view of the small numbers of trees involved, it would be unwise to draw any specific inferences concerning rootstock performance from this data. During 1984 we initiated large scale planting of both our new rootstock selections and older selections such as Duke 6, Duke 7, G6, G6 no. 1, and Hunt alas. In Fig. 1, you can see the widespread distribution of our field trials. We have aimed to include all the major climatic zones and a range of soil types from sandy loam to clay loam. In addition to our own rootstocks, these trials also include about 1000 trees of several selections from our State nurserymen. The largest field trial comprises over 800 trees representing 16 rootstock selections.

The next 5-10 years should represent a period of intensive endeavor and major progress in the field of rootstock research. In a well-known undergraduate textbook on Plant Pathology (Roberts & Boothroyd, 1984), it was recently stated that "the possibility of finding resistant varieties seems remote." This was about avocado root rot! The aims

of our program are to rewrite that epitaph.

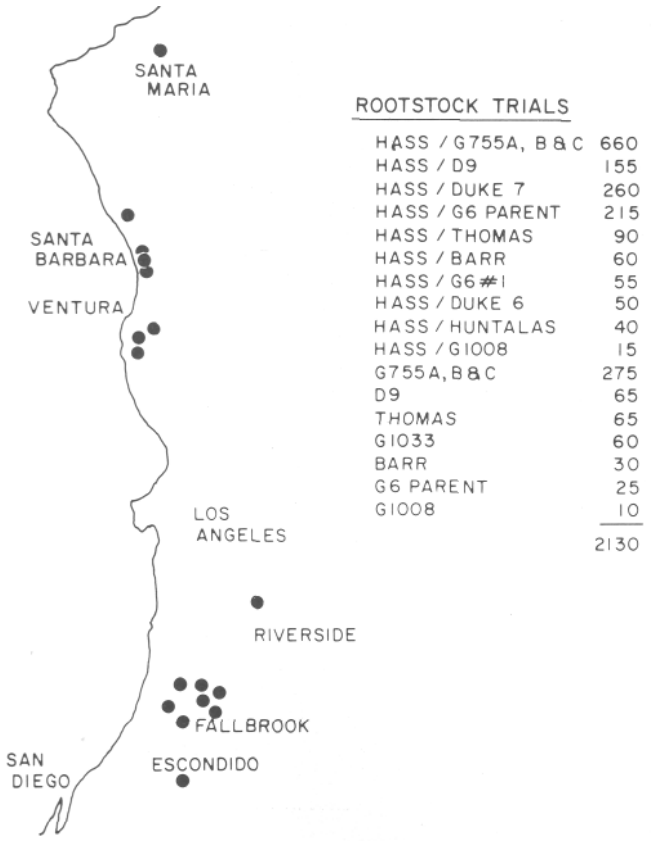

Fig. 1. Distribution map of avocado rootstock trials in progress in California (1983-84).

TABLE 1 Results of a small field trial established in May 1983 in Fallbrook, San Diego County, California with various avocado rootstocks

Rootstock selection	Number of trees	Average decline rating (0-10), months after planting		
		5 mo	11 mo	17 mo
G6/Hass	18	0.3	3.4 ab★2	6.1 a
Duke 7/Hass	10	0.4	5.6 a	6.7 a
G755B/Hass	8	0	0.9 b	0.6 b
G755C/Hass	8	0	3.0 ab	2.1 b
G755B/ungrafted	8	0	0.2 b	0.4 b
G755C/ungrafted	8	0	0.5 b	0.6 b

★1 The trees were treated with 1.5 g a.i./litre of fosetyl-Aℓ prior to planting. There was no fumigation of the soil, and no fungicide was used after planting. Each tree received 1 litre of fungicide solution.
★2 Analysis of variance and Duncan's multiple range test (**P**=0.05).

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