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AN OVERVIEW OF AVOCADO BREEDING AND EVALUATION OF GENOTYPES IN THE REPUBLIC OF SOUTH AFRICA

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Abstract

An avocado breeding programme was initiated in 1991 by the Institute for Tropical and Subtropical Crops (ITSC) in order to develop superior cultivars for Southern Africa. The programme consists of two main parts, namely rootstock and scion breeding, followed by extensive Phase II evaluation. The breeding programmes were founded on the establishment of a gene source, continued introduction of improved overseas material, controlled self- and cross pollinations and evaluations in Phase I orchards. Since the inception of the scion breeding programme, 5,240 seedlings have been established. Eleven local seedlings were selected for Phase II evaluation.

The rootstock breeding programme is devoted exclusively to the selection of *Phytophthora* tolerant types. Over the past three seasons 25,000 seedlings were grown under conditions of severe artificial infection with *Phytophthora.* Thirty three seedlings were selected for further screening.

The breeding and selection programmes are followed by Phase II evaluations. Various rootstock/scion combinations in different production areas are being evaluated for characteristics such as yield, fruit quality, shelf life, etc.. Thus far rootstocks Duke 7, Thomas and Barr Duke have been used in the trials. ne rootstock selections are evaluated in combination with established scion cultivars, Fuerte, Hass, Pinkerton and Ryan. Ninety two scion/rootstock combination are currently being tested in two localities.

1. Introduction

Although the Avocado has been known to westerners for nearly five centuries, and has experienced a great deal of selection pressure over the centuries, there is still considerable potential for the improvement of the current cultivar range (Berg, 1987). Knight & Winters (1971), Slor & Spodheim (1972) and Terblanche (1988) offer various reasons for the need to produce improved cultivars:

* low production efficiency of the available scion/rootstock combinations, alternate bearing
* the need to extend the marketing season with earlier and later cultivars
* the shortage of resistance to scions and rootstock diseases
* need to improve keeping quality and to reduce postharvest physiological disorders

Cultivars developed in California currently form the backbone of the avocado industries of Israel, Chile, Mexico, New Zealand and South Africa (Du Plooy, 1991). Wolstenholme (1987) emphasized that a country has to run its own breeding programme in order to remain competitive. The complexity of climatic, soil and other factors make it unwise for South Africa to rely on California and Florida for improved germplasm.

The ITSC consequently embarked on a local breeding programme in 1991 under the guidance of Dr. Du Plooy.

2. Breeding strategy

2.1 Scion breeding strategy

The programme launched in 1991 provided for a comprehensive effort including genebank maintenance, a planned pollination programme followed by three evaluation phases (Du Plooy et at, 1992).

Open pollinated seeds are collected and planted at an approximate rate of 1250 a year. Selections from these orchards are used for Phase 11 and Phase HI evaluations or as breeding parents.

Records are carefully kept since offspring performance is used to judge breeding values of parent genotypes as the relative breeding value of a cultivar or tree cannot be judged from its phenotype (Bergh & Whitsel, 1975 & Berg, 1987). It is envisaged that a hundred progeny per breeding parent will be produced.

Pollen parent control is expected to accelerate selection progress. Bergh (1987) recommends self pollination as a means of identifying superior breeding parents. Excessive vegetative vigour is reduced by self pollination which may result in greater fruitfulness. Parents of known merits can be used more wisely in corrective mating, repeated back crossing and exploiting favourable combining abilities. (Bijzet & Cilliers, 1995)

Controlled cross pollination is promoted by using trees top worked with various cultivars and caged during pollination. Isozymes are used to distinguish between cross and self pollinated progeny (Bijzet, et al, 1994)

Phase I evaluation of seedlings is followed by extensive Phase II evaluation after grafting on the best commercial rootstock or rootstocks at the time, for evaluation of horticultural traits in Phase II trials. (Sippel et al. 1994) Currently the rootstock in use is the *Phytophthora tolerant* Duke 7. Phase U trials are replicated in different environments. The best selections per location are considered for cultivar status in conjunction with a third phase consisting of a semi-commercial planting. (Sippel et al. 1994)

The breeding and evaluation criteria were discussed by du Plooy et al (1992) and Sippel, et al (1994) and these will be adjusted as consumer preferences change. The main selection criteria are quality, yield and disease resistance.

2.2 Rootstock breeding strategy

The rootstock breeding programme is based on rapid screening of large numbers of seedlings for potential resistance to *Phytophthora cinnamomi* (Du Plooy et al. 1992, Koekemoer, et al. 1994). However, when choosing breeding parents and in subsequent trials, attention is also given to other rootstock characteristics, for example, dwarfing and salinity resistance. Open and controlled pollinated seed, collected from parents known to be tolerant *of Phytophthora*

cinnamomi, are screened at 10 000 a year. The first screening is done by germinating these seeds in *Phytophthora* infected soil followed by drenching the seedlings with a mycelium suspension. Surviving seedlings are clonally multiplied for a second and statistical screening (Bijzet, 1993). In both screenings clonal Duke 7 and Edranol plants are used as controls (Koekemoer et al. 1994 & Breedt, et al. 1995). Selections significantly more tolerant than Duke 7 are grafted with Hass for subsequent field evaluation.

3. Current status of the South African breeding programmes

3.1 Scion breeding

3.1.1 Genebank, pollination and Phase I evaluation

After extensive evaluation of cultivars a new genebank was established in 1994 in a single orchard. It currently includes 41 cultivars, 17 rootstocks and 12 selections planted in two tree replicates. The genebank will constantly be updated in order to include all the possible breeding material in the industry (Bijzet et al., 1994).

By the end of the current season 5090 seedlings, derived from 57 different open pollinated parent cultivars will be established at three localities for Phase I evaluation. Eight selections imported from California were used to produce an additional 150 self pollinated progeny.

Self pollination of caged trees produced a disappointing average of only 21 seeds per tree per season. The self pollination programme will be continued, and the possible problems with this mode of pollination will be investigated and rectified.

Controlled cross pollination will in future be facilitated with 116 pollen parents, planted in transportable pots which will be caged with selected seed parents. Trees were cut back during 1995 to be top worked with multiple cultivars for cross pollination.

Two hundred seedlings of open pollinated sources, planted in 1987 and girdled in 1991 have yielded six selections for further testing. The seed parents were Ettinger, Wurtz, Edranot and Hass. Some Phase I seedlings in other orchards have started flowering and evaluation will commence next season.

An orchard at Levubu, containing imported material and regarded as Phase I, produced fruit that were evaluated. Another season's data will however be obtained before any decisions with regard to the imported selections can be made. At this early stage none of the imported selections except BL 122 and 3-29-5 show any potential. Farmers and homeowners across the country were requested to advise the ITSC of their material with potential. To date more than 100 seedling trees were submitted to the ITSC for evaluation. Very promising material was recovered and five selections are about to be entered in phase II trials. These include a black skin selection (1-14-2) similar to Hass but with significantly larger fruit.

3.1.2 Phase II scion evaluation

The first phase H trials were established in March 1993 at two sites (Burgershall and Levubu). These include four Fuerte selections (vegetative), Hass, Pinkerton, Ryan, Gwen and two local selections. In the following summer another 13 imported and local selections were added to these trials. Each planting is replicated on Duke 7, Thomas and Barr Duke rootstocks. (Sippel, et al., 1994).

Early results indicate that scions on Thomas are growing more vigorously. First yields are better on Duke 7, and Pinkerton and Ryan gave the highest yields. Another 12 imported and local selections will be added in 1996. (Sippel, et al. 1995).

3.2 Rootstock breeding

3.2.1 Pollination programme and Phase I screening

Controlled pollination commenced in 1993 with Duke 7, D9 and Teague being encaged with bees for self pollination. The cross pollination programme was initiated by top working 14 four year old trees with two selected rootstocks each (table 1). A large polycross facility with room for 90 trees and covered with shade cloth will be finalized in November 1995. In the interim, 24 897 seedlings from open pollinated sources were screened for resistance to *Phytophthora* during 1992-1995 (Koekemoer, et al., 1994). Fifty three seedlings survived drenching with the mycelium suspension and after transplanting another 20 of the weaker selections succumbed to *Phytophthora*. The remaining 33 seedlings are currently multiplied for further screening (Breedt, et al., 1995).

3.2.2 Phase II rootstock evaluation

The first phase II rootstock evaluation trials were established during March 1993 at Levubu and Burgershall. These include Duke 7, G6, Thomas, D9 and Martin Grande (G755) each grafted with Fuerte, Hass, Pinkerton, Hass and Ryan (Sippel, et al. 1994).

Initial results indicate that Thomas, G6 and D9 produced more vigorous trees. First yields of Pinkerton on Thomas and Duke 7 are particularly good. Hass performed better on D9 and Duke 7, whilst Ryan did the best on Martin Grande and Duke 7. Fuerte trees hardly set any fruit at this early stage of the trial. (Sippel, et al. 1995)

Current plantings will be expanded in 1996 with five imported and two local selections grafted with Hass.

4. Summary

Since 1991 a total of 5240 seedlings have been established for a Phase I scion evaluation of which 150 are self pollinated. Thus far, six phase I seedlings have been selected for further testing. Almost 25 000 seedlings have been screened for *Phytophthora* resistance resulting in 33 selections. Controlled pollination has been successfully initiated in the programme. PhaseII trials have produced their first crop. Firm conclusions can not however be contemplated yet. An effective South African avocado breeding programme is now a reality. Future development will be followed with great interest and expectations.

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Table 1 - List of avocado rootstocks top worked in order to establish breeding parent combinations
(* Breeding parents A and B were top worked on the same rootstock.)

Combination no.	Breeding parent A*	Breeding parent B*
1	Thomas	G6
2	Thomas	Toro Canyon
3	Thomas	Wurtz
4	Thomas	Duke 7
5	Thomas	Lancefield
6	Thomas	Duke 9
7	Thomas	Barr Duke
8	Colin v33	G6
9	Colin v33	Toro Canyon
10	Colin v33	Wurtz
11	Colin v33	Duke 7
12	Colin v33	Lancefield
13	Colin v33	Duke 9
14	Colin v33	Barr Duke