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Cultivars and Selections in the Phase I Breeding and Selection Programme

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ABSTRACT

The scion breeding programme of ARC-ITSC was initiated in 1991.The aim is to breed improved avocado cultivars adapted to the South African climate with Hass and Fuerte as the standard cultivars in the black and green skin groups respectively. The end of the 1996/1997 season thus signifies the end of the sixth active season of the breeding programme. A summary of the progress up to date is given.

UITREKSEL

Die kultivarteelprogram van die LNR-ITSG het dit ten doel om verbeterde avokado kultivars wat aangepas is by Suid-Afrikaanse klimaatstoestande, daar te stel. Die program het in 1991 'n aanvang geneem met Hass en Fuerte as die standaard kultivars in die swarten groenskil groepe onder \ skeidelik. Die einde van die 1996/1997 seisoen sluit die sesde aktiewe seisoen van die kultivarteelprogram af. 'n Opsomming van die vordering tot op datum word weergegee.

INTRODUCTION

The new breeding programme was initiated at the Institute for Tropical and Subtropical Crops (ITSC) of the Agricultural Research Council (ARC) following a visit of Dr. du Plooy, in 1991, to California. The end of the 1996/97 season thus signifies the end of the sixth active season of the breeding programme. Progresses over the first five seasons were reported on at the SAAGA research symposiums of 1992 to 1996.

This report relates to progress over the period March 1996 to February 1997.

RESEARCH PROCEDURE

The breeding plan decided upon in 1991 at the inception of the breeding programme, primarily comprises five parts:

1. Gene source maintenance
2. A pollination programme
3. Phase I evaluation screening of seedlings

4. Phase II evaluation yield and quality evaluations with grafted selections
5. Phase III evaluation semi-commercial evaluation

The incorporation of new material in the gene source is an essential exercise in order to ensure availability of basic breeding material. This includes imported material and individual selections discovered on farms and in gardens in South Africa. Genetic materials obtained from these sources are evaluated alongside Phase-I trees produced in the breeding programme.

Breeding strategy at the early stages of the programme was determined by the non-availability of proven parents and by the absence of any means to conduct controlled pollination. Phase I trees, produced at a rate of 1 250 per year, are consequently produced with open-pollinated seed collected from commercial cultivars in mixed orchards. These trees are screened for superior genotypes suitable for use as cultivars. Such progenies are also being screened for selection of future breeding parents.

The relative breeding value of a cultivar or tree cannot be judged from its phenotype due to heterozygosity for many loci resulting in many gene interactions, including epistatic and dominance effects. The point is illustrated by Fuerte, which is a fine avocado but fails as a breeding parent both in self-pollination and in crossing with other cultivars (Berg & Whitsell, 1975, Bergh, 1987). It is envisaged that a minimum of 100 open-pollinated progeny of each parent will be evaluated. Sound record keeping enables the breeder to identify the best parents in a planned crossing programme.

Controlled crosses contribute a greater degree of sophistication to the breeding programme. Bergh (1987) is of the opinion that self-pollination of the better cultivars is a worthwhile option as selfed progeny will identify superior breeding parents. He also stated that every cultivar tested, carries the genetic potential to produce the ideal fruit without the need for hybridisation. Excessive vegetative vigour is reduced by self-pollination with the probable result of greater fruitfulness. Another advantage of selfing is that it is a means of removing unwanted recessive genes from breeding populations. Once the breeding values of parents are known, hybridizing on the other hand becomes more valuable in exercises such as corrective mating, repeated back-crossing, utilizing the cumulative effect of favourable genes, and in exploiting specific combining abilities.

Bearing in mind the impracticalities associated with hand pollinating avocado trees, hybridising will be encouraged by top working two cultivars onto one tree. Once the top-worked tree starts flowering, it is enclosed in a cage in order to promote cross-pollination, the pollination agents being either bees or flies. Phase I trees are being produced with seed from such trees. Their pollen parents can usually be identified with isozyme techniques.

Phase I seedlings are evaluated as soon as they come into production. The most promising selections are grafted on the best commercial rootstock at the time, for evaluation in Phase II trials. Currently the rootstock in use is a *Phytophthora*-tolerant rootstock, Duke 7. These grafted trees are planted at different locations for testing. The best selections per location from the Phase-II evaluation are considered for cultivar registration. Progress for 1994/95 will be reported under the following headings:

INTRODUCTION PROGRAMME

Following the attendance of the Third World Avocado congress (1995), the following cultivars were identified for introduction: from California: BL 667, BL 122. Gem, Harvest, Sirprize,Thille, HX73 and 34F2; from Israel: Iriet, Ardith and Gill.

Correspondence with regard to the Californian cultivars was undertaken during 1996. The avocado breeding programme in California will in the future be conducted by Mary Lu Arpaia. The cultivars Sirprize and Gem were supposed to arrive with her visit to South Africa during March 1996 but this, however did not materialize. After further communication, it became apparent that the release of experimental material (especially BL122, Gem and Sirprize) to SAAGA and subsequently the ITSC, is pending due to concerns raised by the Office of Technology Transfer (OTT) and the California Avocado industry, over the national and international distribution of germplasm from the UC breeding programme. In a fax received on 25/7/96 Dr. Mary Lu Arpaia confirmed these objections and arranged that either she or Suzanne Haendel from OTT will contact SAAGA as soon as the matter is resolved. The introduction of the cultivar Thille as a breeding parent will thus be withheld until permission for the introduction of the rest of the experimental material is obtained.

The cultivars Reed and Iriet are available at Westfalia. Westfalia however, signed a non-propagating agreement and is thus unwilling to supply the ITSC with material. It was suggested by the Cultivar evaluation committee at their meeting on 13 August 1996 that Dr. B. Cullers should discuss the possibility of obtaining permission for the release of budwood to the ITSC with Dr. Bloemenveld, while attending the Mango congress in Israel.

Dr. B. Cilliers visited Dr. Amos Bloemenveld on 16 September 1996 and the following became apparent:

- The description of the cultivar Reed, which is in the possession of the ITSC, seems to fit that of the true Reed. Budwood must however be obtained directly from Israel to confirm this by means of isozyme techniques.
- Budwood from the cultivar Green Gold is available and should be obtained seeing that this cultivar can yield up to 40 t/ha.
- Both the Californian selections T142 and H287, which were also evaluated by the ITSC, performs well in Israel. T142 now goes under the name ACE.
- Dr. Bloemenveld would like to obtain Rinton budwood from the ITSC.

Following this visit, renewed correspondence was undertaken with Dr. Bloemenveld for obtaining budwood of Gill, Iriet, Reed and Green Gold cultivars. In the same letter, instructions on phytosanitary requirements for sending Rinton budwood to Israel, were asked for.

GENE SOURCE

The new gene source consisting of 144 grafted trees, in Block L7 at Nelspruit, is now in its third year as the trees were planted on 19 January 1994. Most of the cultivars have

yielded their first fruits. These were harvested from March 1996 to September 1996 and were planted for Phase I screening. Genotypic differences regarding tree characteristics that were already evident during the previous season are now pronounced. These genotypic differences will be investigated and noted during the next three seasons for breeding purposes.

New cultivars to be established in the above orchard were Velvick and Shepard. Unfortunately the grafts did not take and subsequently the trees will have to be remade. The newly imported material mentioned under introductions will also be planted in the gene source.

POLLINATION PROGRAMME

The 1 095 seedlings that were planted during 1995 were transplanted in an orchard at Burgershall research station, during December 1996. The 1993 and 1994 self-pollinations were also planted during the same period in the same orchard, during 1996, 1 000 seeds were collected of which only 800 were planted in the nursery, due to foreseen shortage in orchard space with regard to the following planting season. Table 1 summarizes the number of seedlings that were transplanted as well as the seedlings that were transplanted during December 1996.

Table 1
Number of seed collected from 1993 to 1996 and the number of seedlings produced from these collections

Harvest Year	*Seed Collected*	*Seed Planted*	*Seedlings Germinated*	*Transplanted*
		Open-pollinated seed collected		
1995	1 185	1 185	1 095	1 051
1996	1 000	800	Not available	Not available

In order to ensure continuity in a slow moving breeding programme as with avocados, it is essential to add annually to Phase I plantings.

The numbers of seedlings planted over successive years are given in table 2. In table 3 the areas planted with Phase I material are given.

Table 2
Avocado seedlings planted in successive years

Seedlings planted in sucessive years

Harvest year	*Seedlings*	*Transplated*	*In year*
1991	500	500	1993
1992	1 142	1 134	1993
1993	1 000	625	1995
1994	1 353	1 300	1996
1995	1 095	1 051	1996
1996	800	Not available	Not available
Total	5 890		

Table 3
Avocado seedlings planted in different areas

Different localities planted

Locality	*Type*	*Year*	*Trees*
Nelspruit	Introduction	1985	100
Levubu	Introduction	1990	72
Burgershall	Phase I	1989-90	200
Burgershall	Phase I	1993	500
Tzaneen*	Phase I	1993	1 134
Levubu	Phase I	1995	625
Levubu	Phase I	1996	1 300
Burgershall	Phase I	1996	2 040
Nelspruit	Gene Source	1994	144
Nelspruit	Topwork	1995	400

* Orchard has been removed during 1996 as is discussed under Phase I evaluation.

Phase I evaluation

Approximately 200 seedlings from open-pollinated sources, planted during 1987 at the Burgershall experimental farm, and girdled in 1991, produced fruit and could be evaluated. Six of these displayed promising features: one each out of Ettinger and Wurtz and two each from Edranol and Hass. Two of these selections namely the Wurtz (87-7/1) and one of the Edranol seedlings (87-17/1) are included in the Phase II evaluation programme and have been planted in trials at Burgershall and Levubu. The other four selections (89-25/1, 87-16/1, 87-16/2 and 87-17/2) will be included as soon as enough budwood is available for the production of Phase II trees.

The 1 134 Phase I trees planted during 1993 at Westfalia Estate, Tzaneen by courtesy of Merensky Technological Services, are growing satisfactorily and the bearing trees were evaluated during the 1996 season. The Westfalia Hass inter-plants were however affected by the vigorous growth of the seedling trees and were not performing to

standard expectations. The ITSC was asked to evaluate seedling trees before the end of June 1996 as the trees would then be removed. Upon evaluation only 1,5 % of the trees were found to be bearing fruit. None of these however had outstanding characteristics. Budwood however, was taken from trees that appeared to be close to flowering and the most promising selections in this regard were marked in order not to be removed for at least one more season. Trees with specific tree characteristics were also identified and budwood were taken. The budwood of approximately 300 selections was grafted to seedling rootstocks at the Burgershall research station resulting in a total of 753 trees which will be planted early in 1997.

CONCLUSION

Trees planted in the new gene source, on 19 January (orchard L7) are growing exceptionally well. Information with regard to breeding parents and seed will be available from this orchard during 1997. Phenotypic differences among trees are already apparent. During 1996 only 1 000 seeds were collected and 800 were planted due to the 300 selections from Westfalia that had to be grafted and replanted. Six Phase I selections are in the nursery phase, for production of Phase II trees. Phase I trees at Burgershall and Westfalia, planted during 1993, are still in a juvenile stage, but some of the trees came into production during 1996. It is possible that promising material has been discarded by the actions in the Westfalia orchard. It was decided that no Phase I seedlings will be planted again on donated land without a proper contract. All phases of the breeding programme have now been implemented, culminating in an exciting programme, driven by a motivated team and funded by avocado producers via SAAGA.

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