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Avocado Cultivar Breeding — Results and Prospects

Z. Bijzet B. Cilliers A.D. Sippel B. Snijder
ARC-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200

ABSTRACT

In 1991 ARC-ITSC initiated a breeding programme to improve avocado cultivars adapted to the South African climate, with Mass and Fuerte as the standard cultivars in the black and green skin groups respectively. The end of the 1995/96 season is therefore the end of the fifth season of the breeding programme. A summary is given of the progress to date.

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 1995/96 season was the fifth active season of the breeding programme. Progress during the first four seasons was reported in the 1993/94 progress report, and at the South African Avocado Growers' Association research symposiums of 1992 to 1994.

This report relates to progress during the period March 1995 to February 1996.

RESEARCH PROCEDURE

Essentially, the breeding plan formulated in 1991 at the inception of the breeding programme, 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; and
5. Phase-Ill evaluation — semi-commercial evaluation.

The incorporation of new material in the gene source is essential 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 in 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

pollinations. Phase1 trees, produced at a rate of 1 250 per year, are therefore 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 progeny is also being screened for selection of future breeding parents.

The relative breeding value of a cultivar or tree cannot be judged from its phenotype because heterozygosity for many *loci* result in many gene interactions, including epistatic and dominance effects. This 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 (Bergh & 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.

A controlled cross gives the breeding programme greater sophistication. Bergh (1987) maintains that self pollination of the better cultivars is a worthwhile option, because progeny from self-pollination will identify superior breeding parents. He further maintains that every cultivar tested carries the genetic potential to produce the ideal fruit without the need for hybridization. Excessive vegetative vigour is reduced by self-pollination, with the probable result of greater fruitfulness. Another advantage of self-pollination is that it is a means of removing unwanted recessive genes from breeding populations. On the other hand once the breeding values of parents are known, hybridizing 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, hybridizing 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 crosspollination, 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 onto 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 various 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

After attending the third World Avocado Congress, we identified the following cultivars for introduction:

- from California — BL 667, BL 122, Gem, Harvest and SirPrize; and
- from Israel — Iriet, Ardith and Gill

Correspondence on this matter was undertaken at the end of March 1996.

GENE SOURCE

The new gene source consisting of 144 grafted trees in Block L7 at Nelspruit is now in its second season, having been planted on 19 January 1994. The orchard is now bearing the first fruit. This fruit will be evaluated from March 1996 to September 1996. Phenotypic differences in tree characteristics that were already evident during the previous season are now pronounced.

New cultivars to be established in the above orchard have been identified as Velvick, McPhie and Simmonds. Only budwood of Velvick and Shepard could be obtained. The newly imported material mentioned above under the heading 'Introduction programme' will also be planted in the gene source.

POLLINATION PROGRAMME

During 1994 a germination rate of 93 % resulted in 1358 seedlings. These seedlings, along with 1993 seedlings that could not be planted in 1994 due to a water shortage at the Burgershall research station, were planted in December 1995 and January 1996 at the Levubu research station. Another 1 185 seeds were planted, and these produced 1 095 seedlings. These will be planted at Burgershall in September 1996, along with the 1993 and 1994 self-pollinations. Table 1 summarizes the number of seedlings that were transplanted, and those that will be ready for transplanting in September 1996. The table gives a detailed account of the seed collected and planted in 1996.

Table 1
Number of avocado seeds collected in the period 1993–1995, and the number of seedlings produced from these collections

Harvest year	*Seed collected*	*Seed planted*	*Seedlings germinated*	*Trans-planted*	*Survived*
		Open-pollinated seed collected			
1993	1 296	1 259	1 002	625	N.a.
1994	1 483	1 460	1 358	1 300	N.a.
1995	1 185	1 185	1 095	N.a.	N.a.
		Self-pollinated seed collected			
1993	50	48	39	N.a.	N.a.
1994	126	120	106	N.a.	N.a.

N.a. = Not available

To ensure continuity in a slow-moving breeding programme (as is the case with avocados), it is essential to add annually to phase-I plantings. The number of seedlings planted in successive years is given in table 2.

Table 2
Avocado seedlings planted in successive years

Harvest year	*Seedlings*	*Transplanted*	*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	****	****
Total	5 090		

Table 3 shows the areas planted with phase-I-material.

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 features: one each out of Ettinger and Wurtz, and two each from Edranol and Hass. Two of these selections — 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.

Table 3
Avocado seedlings planted in different areas

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	1 468
Nelspruit	Gene source	1994	144
Nelspruit	Topwork	1995	400

The 1 018 phase-I trees planted during 1993 at Westfalia Estate, Tzaneen, are growing satisfactorily, and the bearing trees will be evaluated during the following season (1996). Four of the 313 young trees planted in orchard B6 at Burgershall have flowered but no fruit was produced. The introduction orchard of imported cultivars at Levubu, treated as phase I, was evaluated, but another season's data will need to be collected

before any recommendations can be made. At this early stage none of the imported selections except Reed shows any potential. Summarized data for these selections will be included in the next report.

CONCLUSION

Trees planted in the new gene source, on 19 January 1994 (orchard L7) grow exceptionally well. Canopy growth is vigorous and trees show a healthy colour. Phenotypic differences between trees are already apparent. In the period 1991-1995 5 090 seeds were collected and planted.

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. Some of the trees are expected to come into production in 1996. 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 the South African Avocado Growers' Association.

REFERENCES

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