

Pear Breeding by the ARC Underlining the Scope, Associated Research Initiatives and a General Overview of South Africa Pear Industry

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Abstract

Statistics of pear production in South Africa (scope, cultivar distributions) are provided. The importance of blush cultivars for the South African pear industry is emphasized and the history of blushed cultivars released by the Agricultural Research Council (ARC) and current breeding objectives are briefly described. The system of student training aligned with industry desires to target the development of molecular markers and the challenge to obtain new germplasm for specific traits of importance are reflected. The process of releasing new cultivars is explained with Cheeky® as an example and detailed information of Cheeky® is given. The future direction of pear breeding by the ARC and the use of marker assisted selection (MAS) is outlined.

Keywords: Cheeky®, MAS, pear breeding, South African pear statistics

ARC Armut Islahı, İlgili Araştırma Girişimleri ve Güney Afrika Armut Endüstrisine Genel Bir Bakış

Özet

Bu derlemede; Güney Afrika'daki armut üretim istatistikleri (kapsam, çeşitlilik) incelenmiştir. Güney Afrika armut endüstrisi için renkli çeşitlerinin önemi vurgulanmakta ve Tarımsal Araştırma Konseyi (ARC) tarafından geliştirilen kırmızı çeşitlerin tarihi ve mevcut islah hedefleri kısaca anlatılmaktadır. Moleküler markırların gelişimini hedefleyen endüstriyle uyumlu öğrenci eğitimi sistemi ve bazı özel karakterler için yeni bir gen havuzunun elde edilme zorunluluğu açıklanmıştır. Yeni çeşit geliştirme süreci Cheeky® armut çeşidi örnek olarak açıklanmış ve Cheeky® ile ilgili ayrıntılı bilgileri verilmiştir. ARC'nin armut islah stratejilerinin geleceğinin yönü ve marker yardımcı seleksiyon (MAS) kullanımı açıklanmıştır.

Anahtar kelimeler: Cheeky®, MAS, armut islahı, Güney Afrika armut istatistikleri

1. Introduction

Pears in South Africa and general statistics

The first planting of pears, in what is now South Africa, dates back to the Dutch settler, Jan van Riebeeck, of the Dutch East India Company who planted a circle of 'Saffraan' pear trees in the 17th century. One of the original trees now aged more than 360 years, is still surviving in the Company's Gardens in Cape Town. South Africa now ranks sixth in the world in terms of production of European pears (after USA, Italy, Argentina, Turkey and Spain), but it is the fourth largest pear exporter (after Argentina, Netherlands and Belgium). Pear is South Africa's third largest fruit crop (12 211 ha), after grapes and apples. The production of European pear cultivars was 413 614 t in 2013/14, of which 12% was distributed to the local fresh market, 36% was canned, 3% was used for drying and 49% was exported fresh. Of the 202 670

t of pears exported, most were shipped to Europe and Russia (55%), followed by the Far East and Asia (15%), Middle East (14%), United Kingdom (9%), Africa (3%), USA and Canada (2%) and other countries (1%) (Hortgro, 2014).

The vast majority of pears are planted in the scenic Western Cape Province mainly in the Ceres and Grabouw regions. The most important cultivars are 'Packham's Triumph' - 3 980 ha, 'Forelle' - 3 193 ha, 'Bon Chrétien' [synonym: 'Williams' or 'Bartlett'] - 2 675 ha, 'Abate Fetel' - 748 ha, 'Rosemarie' - 432 ha, 'Beurre Bosc' - 258 ha and 'Cheeky®' - 241 ha (Hortgro, 2014). These cultivars make up more than 90% of the total area planted and are mostly very old cultivars, except for 'Rosemarie', which was released in 1990 and 'Cheeky®' which was released 6 years ago after a 16-year developmental phase. The Agricultural Research Council (ARC), through its pear breeding

programme at Infruitec-Nietvoorbij, aims to develop new cultivars that will increase the export market for South African pears. Blush pears are popular with overseas consumers, and may receive prices up to three times that of normal green/yellow cultivars. Blushed pears now account for 33% of the total pear planting in South Africa, but contribute an estimated 46% of the crop export earnings. Development of new blushed pears is consequently a major objective of the breeding programme (Figure 1, Figure 2), which has already released several blushed cultivars: ‘Rosemarie’ in 1990 (Jolly et al., 1990), ‘Flamingo’ in 1993 (Jolly, 1993) and, more recently, ‘Cheeky®’ in 2009 (Human and von Mollendorff, 2009).

Breeding objectives

The ARC pear breeding programme is funded partially (30%) by private industry [(Hortgro Science via SA Apple & Pear Producers’ Association (SAAPPA)] and partially by a parliamentary grant (70%). Breeding objectives are therefore aligned with pear industry projections, and revised regularly according to industry needs. The most important focus is on developing new cultivars adapted to producing good blush under warm weather conditions (Human, 2013).

Specific attributes selected for in the ARC breeding programme are:

Adaptability	medium (as opposed to low) chill requirement
Cropping	precocious reliable – regular and heavy (more than 45 t/ha) very early (Week 52) to late (Week 12)
Fruit appearance	blush (heat-stable) or fully red or brown (fully russet) or green (to replace ‘Packham’s Triumph’) medium to large acceptable shape
Eating quality	texture – juicy & melting with no stone cells flavour – strong pear good storage potential (3-6 months at regular atmosphere)
Novelty	very small (baby/miniature) novelty shapes and flavours Asian pears and hybrids

One of the main breeding objectives is to ensure that offspring will be better adapted to South African growing conditions, in particular by having lower chilling requirements as South Africa is much warmer in winter than most European regions. It is predicted that South Africa will become warmer still as a result of climate change, therefore breeding for lower chilling is a prime objective. Fortunately, most of the serious pests and diseases affecting pears (such as fire blight and pear psylla) are not present in South Africa, so pests and disease resistance is currently not a priority in the ARC breeding programme. Nor does it place much emphasis on growth habits (wide crotch angles) or compatibility with quince rootstocks as most of these traits are not of major significance to our industry.

Basic research and student training

The ARC also focuses on other more general scientific research and human resources development. In collaboration with Stellenbosch University (SU), the ARC is involved in training postgraduate students, with government funding from the Technology and Human Resources for Industry Programme (THRIP) via the National Research Foundation of South Africa. Recently, one ARC student received his MSc for research on the use of microsatellite markers to screen our pear germplasm collection for “trueness to type”, comparing the data with information from Brogdale (UK). His results show that some accessions in our germplasm collections are not “true to type”. Presently we also have a PhD student working on the mapping of agronomic traits in European pear. In this study he is focusing on the inheritance of some morphological traits and the possible genetic control of the blush trait in a seedling population derived from ‘Forelle’. The main target of this study is to find possible markers for the blush trait which could be used for early screening of seedlings using marker assisted selection (MAS).

Germplasm

A major challenge for the pear breeding programme is obtaining genes for specific breeding objectives, as the germplasm collections of the ARC are inadequate and lack donor genes for certain specific traits. Finding overseas breeders and other sources that can provide suitable material is difficult, since many overseas breeding programmes are privatised and dependent on generating income from new cultivars, and therefore are less likely to share their genetic resources with other breeders. Since many of the common European pests and diseases of deciduous fruits are not present in South Africa, the South African Department of Agriculture, Forestry and Fisheries (DAFF) enforces strict



Figure 1. One of the ARC new blush selections harvested late in the season and with a crunchy texture

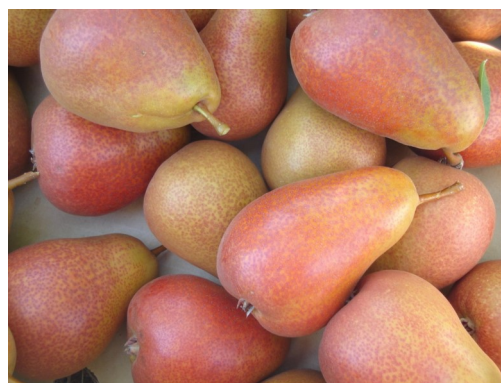


Figure 2. A fruit sample of one of the ARC new selections with a blush on russet background together with good flavour and eating qualities

control over the importation of any plant material and pollen to prevent new pathogens from entering the country. Precautionary measures imposed by DAFF on material not meeting all the entry requirements can, in many cases, result in the destruction of the imported plant material. Consequently, many of our plant or pollen imports are not released from quarantine. Importing germplasm material by means of *in vitro* culture is a possible solution, but finding sources prepared to this can be problematic and expensive.

More detail information on 'Cheeky®', early justification, testing and commercialization

This cultivar was initially selected (selection number 3D-13-34) from the Drostersnes Experimental Farm of the ARC in the Grabouw region during 1999, and planted in Phase 2 orchards at Elgin Experimental Farm (also Grabouw region) during 2001. After the first fruit from this trial site were harvested and stored, evaluation suggested future potential. In collaboration with industry leaders and Culdevco (Pty) Ltd, the new selection was trialled at evaluation sites of three major export companies under contract by Culdevco, ARC's licensee for the local and international commercialization of ARC-bred cultivars.

Once sufficient exportable volumes became available in 2005 the first samples were shipped to markets in Europe for comments and feedback. The feedback received from most supermarket chains was consistently favourable. Consequently, in collaboration with industry, it was decided to release this selection during May 2009 under the trade name 'Cheeky®'. The Plant Breeder's Right varietal name was originally 'ARC Pear-1' but was subsequently changed to 'Cape Rose' in 2012.

The fruit of 'Cheeky®' are large, with a dark red blush, pleasing taste and texture and with good



storage potential. These attributes make 'Cheeky®' pears a very attractive product, both to producers and consumers in many international supermarkets. Another major benefit of 'Cheeky®' for industry is the time of harvest, which fits well between early blush cultivars (such as 'Rosemarie' and 'Flamingo') and later seasonal harvesting of much larger volumes of 'Forelle' pears. This selection also allows the SA pear industry to constantly supply the overseas supermarkets with blush pears until larger volumes of 'Forelle' are available later in the South African pear season.

Looking ahead

It is expected that, before long, South Africa will be severely affected by climate change resulting in lower winter chill and hotter, dryer and windy summers in all traditional pear growing areas. This will lead to reduce the persistence of blush and will increase sunburn and rub marks. Therefore, greater emphasis is being placed on breeding for low chill and serious attention should be paid to more stable blush pigmentation, greater sunburn resistance and reduced susceptibility to rub marks. Appropriate germplasm is required for all these future and other challenges. Marker assisted selection (MAS) for these and other economically important traits has the potential to reduce the number of seedlings planted in evaluation orchards, thereby saving on costs, but the use of MAS for pear breeding is not yet routine. Regarding exchange of germplasm *in vitro*, finding and applying suitable markers for important traits and the training of students, the ARC is keen to develop international collaborations.

References

Human JP, 2013. Breeding Blush Pears (*Pyrus communis* L.) in South Africa. Acta Horticulturae 976: 383-388.

CULTIVAR INFO SHEET : Cheeky® Cultivar name: 'Cape Rose'	
Released May 2009 Selection no. 3D-13-34 Usage Dessert Origin ARC Infruitec- Nietvoorbij Exclusive licensee Culdevco (Pty) Ltd	 
TREE CHARACTERISTICS	REMARKS
Growth habit Bearing habit Chilling requirement	Spreading and vigorous On spurs and young shoots Medium (900 Infruitec units)
FRUIT CHARACTERISTICS	
Shape Size Colour Taste and texture Lenticels Stem length	Turbinate/ oblong-ovate-pyriform (egg-shaped) Good (average size 170g/fruit) Bright blushed skin (retains blush during heat waves) Sweet, juicy with pear flavour, excellent eating quality Conspicuous Intermediate
PRODUCTION CHARACTERISTICS	
Harvest date Production Full bloom date Pollinators Storage ability	Late January Good Between 'Forelle' and 'Packham's Triumph' 'Forelle', 'Abate Fetel', 'Rosemarie', 'Flamingo' Good at regular atmosphere for 10 weeks at 0°C
PRODUCT GRADING	
Product type	Attractive blush with good eating qualities
GENERAL * = Plant Breeders Rights: ARC Infruitec-Nietvoorbij	The growth of trees is vigorous but it was not tested on all dwarfing rootstocks e.g. BA29. Incompatible symptoms on quince C51 were noted. Flower formation on BP1 rootstock was weak, but girdling shows very good results. Most flowers in clusters do set fruit, resulting in clustered fruit formation, which needs thinning.

Human T, von Mollendorff L, 2009. Cultivar Info: Cheeky®. Cultivar Information Sheet, ARC Infruitec-Nietvoorbij, Stellenbosch, South Africa.

Hortgro, 2014. www.hortgro.co.za

Jolly PR, Stadler JD, Louw PF, Smith WJC, Visagie TT, Fourie PC, 1990. Rosemarie: The first South African Pear Cultivar. Information Bulletin Number 594, Fruit and Fruit Technology Research Institute, Stellenbosch, South Africa.

Jolly PR, 1993. Release of the Pear Cultivar - Flamingo. Information Bulletin Number 625, Fruit and Fruit Technology Research Institute, Stellenbosch, South Africa.