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PLANT BREEDING WITH A WOODY PERENNIAL — THE GRAPEVINE

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HISTORY

The idea of breeding grape cultivars specifically for Australia is almost as old as Australian viticulture itself. The Macarthurs, more famous for their activities with sheep, also grew grapes and believed that they should raise vines from seed to allow selection of types suited to local conditions. Busby (3) records that William Macarthur had 250 such seedlings, out of a much larger number raised from seed in 1824, under trial. None of these appear to have survived and this may be because they were not the result of deliberate crosses but raised from open-pollinated

seed. We now know that most of this would be self pollinated and the seedlings would lose much of the heterotic vigour of the parent. Busby himself (2,3) advocated a deliberate breeding program as the surest means of obtaining grapes suitable to the climate.

Busby went to Europe and made as complete a collection of grape cultivars as he could to establish in Australia with the intention of systematically testing them (4). Unfortunately he left Australia soon afterwards and this testing was never done. The collection was allowed to degenerate into confusion which was further confounded when collections were established from it in Victoria and South Australia. Ultimately the whole effort appeared to be dissipated and lost. In fact, more of these cultivars survive than is generally realised and our Division is trying to collect them from old vineyards before they are finally lost. Having left Europe before grafting was needed they are often in a good state of freedom from virus diseases.

In any case it was found that some cultivars would grow well in suitable localities in Australia and that they would produce wines true to cultivar, a fact very much counter to the doctrine prevailing in Europe at that time. This may be one reason why Busby's recommendation of a deliberate breeding program was not followed up.

The first European grape breeding program was started at about this time with a clarity of definition of objective and plan of action which could hardly be improved upon now. Louis Bouschet considered that a cultivar which would impart more colour to the red wines of Mediterranean France was needed. He began in 1824 by collecting from other areas of France cultivars which gave the wines of most colour. When he found that none of them would grow very well in his area he chose the one he thought gave the most colour, 'Teinturier du Cher' and, in 1828, crossed it with some of the local vigorous and high yielding cultivars. From the cross with 'Aramon' came 'Petit Bouschet', a little of which is still grown, but which still did not have the vigour and yield desired. His son Henri Bouschet carried on the work by crossing 'Petit Bouschet' with the local cultivars and, from the cross with 'Grenache', came 'Alicante Bouschet' which is still a very successful cultivar. Since then there have been many breeding efforts in many countries. Sometimes the only objective seems to have been the breeder's wish to produce a cultivar to name after his patron, his family or friends, or even himself. This has resulted in the world's cultivar collections being cluttered up with cultivars of no observable value and is not a practice to be recommended. On the other hand, some very successful cultivars have been produced by people who knew what they were looking for and, in Germany, for example, the

stage has now been reached where more than half the wine is produced from deliberately bred cultivars. At one stage about $\frac{1}{3}$ of French vineyards was planted with disease resistant hybrids and a few of the best of these are still extensively grown.

The reports of the Queensland Acclimitization Society from 1899 to 1910 contain a harrowing serial of what may have been the first Australian grape breeding program. This was plagued by the necessity to shift the plantings on several occasions at short notice with consequent heavy losses of vines and terminated by financial difficulties with the wholesale retrenchment of staff. However, in its heyday it claimed one record, a seedling which bore ripe fruit only 14 months after the seed had been sown. This shows the advantage of carrying out such a program in a climate encouraging vigorous growth and development. There is little doubt that it had the potential to produce a backyard table grape suitable for the humid coastal areas of Queensland.

The first deliberately bred cultivar to be named in Australia was a table grape, 'Nyora', introduced by the New South Wales, Department of Agriculture in 1963. The breeder, Mr. W.J. Pogendorf, who was primarily a cereal breeder, made the cross at Yanco in 1937. There have been a few other small breeding programs which did not continue long enough to give rise to any new cultivars, although a few selections from these are still being maintained. Breeding at CSIRO Division of Horticultural Research began in 1964 and has continued at varying intensity every since.

TECHNIQUES

Grape flowers come in three sexual types. Wild vines are dioecious, with male and female flowers borne separately on different vines, and some cultivated vines have female flowers. The third type, hermaphrodite, appears to be a sport which can be maintained only under cultivation. There is no mechanism for discouraging self pollination, which may explain why it does not establish in the wild. Male is dominant to hermaphrodite and both of these are dominant to female. Male flowers can be induced to produce pistils which will set seed by treatment with a suitable cytokinin (6), so it is possible to make crosses in all combinations except female \times female or seedless female \times any type. In practice, because hermaphrodite cultivars set fruit most reliably, the combinations most often used are hermaphrodite \times hermaphrodite and female \times hermaphrodite. Homozygous hermaphrodite cultivars are advantageous, particularly in the second case; well known cultivars with this character include Riesling, Chardonnay, and Muscat Hamburg.

Breeding techniques for grapes have been revised by Einset and Pratt (5). At Merbein we usually collect pollen on a glass

plate from attached inflorescences, emasculate with pointed forceps and pollinate with a camel hair brush. Brown paper bags folded over and secured with paper clips are used to exclude unwanted pollen. Grape seeds need to undergo a period of cold, from about 2 to 12 weeks according to cultivar, before they will germinate. We usually plant the seed as soon as the fruit is harvested and keep the seed boxes at about 2°C but it is also possible to store the fruit at this temperature and then extract and plant the seed. The boxes are transferred to a glasshouse held to about 25 to 30°C by day and 15 to 20°C by night for germination. To maintain seedling growth during winter we give a light break of one hour in the middle of the night. We leave seedlings in the boxes and plant directly in the field in late spring or early summer 1m apart in rows 2.5m apart. Seedlings which are likely to be of any value should produce enough fruit for evaluation in their 3rd, 4th and 5th years.

OBJECTIVES

Australia usually ranks only about 16th among the countries of the world as a producer of wine grapes but ranks about 4th as a producer of grapes for drying. This usually means that grape production is split more or less equally between winemaking and drying, and so grape breeding in Australia should consider both end uses.

Nearly $\frac{3}{4}$ of the grapes used for wine in New South Wales, Victoria, and South Australia come from the irrigation areas of the Murrumbidgee and Murray Valleys and most in Western Australia from areas near Perth. The climate in these areas more nearly resembles that of north Africa than that of Europe.

Most of our wine grapes come from Europe, particularly from France. These cultivars are not necessarily suited to the hot areas. They ripen while the weather is still very hot and are likely to lack both acid and flavour compounds. A few cultivars brought in recently from southern Italy are better in this respect but they still have some disadvantages.

We are therefore trying to breed wine grape cultivars that ripen later in the season and maintain a good acidity as they ripen

In contrast to wine grape cultivars, ripening in the hot weather is desirable in the case of drying grapes, to give suitable conditions for natural drying. The main improvement required over existing cultivars is an ability to withstand the effect of rain on grapes that are almost ready to harvest. Only Greece, among the major producers of dried grapes, has such uncertain weather at harvest time as Australia.

Although the requirements for new drying and wine grapes

for our hot areas would appear to be so different, there is so much variation among seedlings raised from the same parents that it is possible to make selections for both purposes. Thus we felt justified in using 'Sultana' as one parent in many of our early crosses. It is Australia's leading drying grape and might give offspring with seedless grapes, a very desirable feature for a drying cultivar. In many seasons it is also Australia's leading wine grape in quantity crushed, and has desirable characteristics, such as good acidity, which it could contribute to new wine grape cultivars. Because most 'Sultana' offspring have seeded fruit and are not suited as drying cultivars this is an important consideration.

The range of variation available for selection cuts across ideas about the best areas for producing quality wines. There may be a special relationship between area and cultivars, and with different cultivars it may be possible to produce quality wines in apparently unpromising areas. Because poorly adapted cultivars produce grapes lacking acid and flavour in the hotter parts of the Murray Valley it is often assumed that this is a characteristic of the area. However, seedlings raised at Merbein indicate that this is not so. Some have such a long growing season that they do not ripen their fruit and others have fruit with enough sugar but so much acid that their wines are undrinkable by themselves. The new Merbein cultivar, Tarrango, a red wine grape named in 1975, gives wines in the Murray Valley similar in composition to those from French cultivars grown in much cooler areas.

A more recent breeding objective is the incorporation of resistance to fungal diseases. As well as reducing the amount of energy required for grape production, this is a more environmentally acceptable method of disease control, a point which could be of some significance when so many consumers visit wineries and their vineyards. Disease resistant cultivars could be particularly important in areas such as the Hunter Valley where the summer rainfall and humidity are favourable to fungal development. The French hybrids, produced by private breeders in France between about 1880 and 1950 using American species, such as *Vitis rupestris*, in crosses with cultivated cultivars, are a good source of resistance. With the long history of breeding behind them some of the more recent hybrids show an acceptable combination of quality and resistance. Some of them give seedless offspring when crossed with seedless cultivars so we are using them for breeding both drying and wine cultivars.

Of more than 40,000 seedlings so far raised in our programme, evaluation of 30,000 seedlings is well advanced. To date, four cultivars have been named (1) and three are likely to be in the near future.

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METHODS USED IN AVOCADO BREEDING

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Abstract. A hybridization programme involving controlled hand pollinations has been developed for the avocado. The floral mechanism is very temperature-sensitive and crosses are carried out in a temperature-controlled glasshouse to ensure suitable conditions for pollen tube growth and fruit set. Grafting techniques are used to ensure synchronous flowering of cultivars which otherwise would not flower at the same time. Because the majority of pollinated fruitlets abscise an embryo-culture method is under development to increase the numbers of progeny obtained from each cross. Progeny are topworked onto large stumps for a rapid assessment and are also planted out on virus-tested seedling stocks.

The avocado (*Persea americana* Mill.) is a relatively new crop to Australia and the industry is based largely on cultivars developed overseas. These cultivars do not entirely satisfy the requirements of the Australian industry and are not suitable for the wide range of climates present in Australia. There is demand for year-round supplies of fruit and there are also problems with existing cultivars due to the biennial bearing habit. Other scion characteristics of interest include time of flowering, fruit colour, shape and size, skin thickness, seed size, and fresh flavour, quality and oil content. Desirable rootstock characteristics include salinity tolerance, resistance to the root rot fungus *Phytophthora cinnamomi*, and a dwarfing habit.