Continuing to report on Potatoes in Practice 2005, this paper was delivered as one of the five seminars by the two key staff at SCRI involved with potato breeding

FUTURE DIRECTIONS IN POTATO BREEDING AT SCRI

Selectors, hybridisers and scientific breeders

The principal cultivated potato, *Solanum tuberosum*, was introduced into Europe, and thence the rest of the world, from South America in the late 16th century. By the end of the 18th century it had been adapted to the long day conditions of northern latitudes through selection by the early cultivators for earlier-tubering, higher-yielding potatoes derived from seedlings from naturally occurring berries, the consequence of pollination by bumble bees. Potato breeding in the modern sense began in 1807 in England when Knight made deliberate hybridisations between cultivars by artificial pollination. It flourished in Britain and elsewhere in Europe and North America during the second half of the 19th century and the early 20th century when many new cultivars were produced by farmers, hobby breeders and seedsmen. Famous Scottish breeders were William Paterson of Dundee, who bred Victoria (released in 1863), John Nicoll of Arbroath who bred Champion (1862) and Archibald Findlay from Fife who bred Majestic (1911). This tradition was continued by Donald Mackelvie of Lamlash, Isle of Arran, who bred the Arran cultivars, including the widely grown first early Arran Pilot (1931). More recently, Jack Dunnet bred the Caithness potato cultivars of which Nadine (1987) is probably the best known.

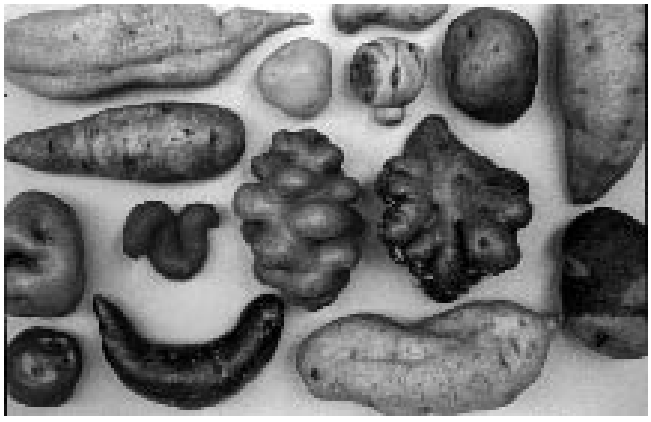
However, it was the rediscovery in 1900 of Mendel's published work of 1865 that marked the birth of modern genetics, and opened the way to crop improvement by scientific breeding methods based on a sound knowledge of the inheritance of economically important traits. The development of such methods for potatoes was one of the challenges which faced the Scottish Plant Breeding Station (SPBS) on its foundation in 1920, and one which still faces potato breeders at SCRI today (SCRI was formed in 1980/81 by the amalgamation of SPBS with the Scottish Horticultural Research Institute in Invergowrie, Dundee). Potato Breeding at SPBS up until 1976 was reviewed by Holden (1977) and at SPBS/SCRI from 1976 to 2001 by Mackay (2003). Together, these reviews cover 67 cultivars, from The Alness (1934), through the Craigs and Pentland series, to the most recent ones such as Lady Balfour (2001). At Potatoes in Practice (SCRI, 11 August 2005), we outlined future directions in potato breeding at SCRI, in what is now called the genomics age.

The need for new cultivars

Given that over 4000 cultivars are listed in the 2005 edition of the World Catalogue of Potato Varieties (Hils & Pieterse, 2005), it is reasonable to start by asking if there is really a need for new ones. The answer is yes, and at least two contrasting scenarios can be seen. In the European Union the potato industry is trying to increase potato usage in an economically and environmentally sustainable way. New cultivars must give more yield of saleable product at less cost of production. They must have inbuilt resistances to pests and diseases (particularly cyst nematodes and late blight), and increased water and mineral use efficiency, that allow reduced use of pesticides and fungicides and better use of water and fertilisers. Finally, they must help meet consumer demands for healthy, flavoursome, convenience foods. In contrast, we should not forget that in Asia and Africa there is a need for increased and stable potato production to meet an ever increasing demand for food. New cultivars must deliver higher yields under low inputs, disease and pest attacks, and environmental stresses such as heat, cold, drought and salinity. If possible, they should also have improved nutritional and health properties, but the greatest need is to raise fresh weight yields from a world average of 17 t/ha to European and North American levels of 45 t/ha (Lang, 2001).

Breeding new cultivars

Potato breeding has traditionally involved making crosses between pairs of parents with complementary features and this is likely to remain the main route to new cultivars. The aim is to generate genetical variation on which to practice selection over a number of vegetative generations for clones with as many desirable characteristics as possible for release as new cultivars. Increasingly, however, parents will have genes from wild species and may also be from complementary groups of cultivated germplasm to exploit hybrid vigour. At SCRI we are fortunate in having the Commonwealth Potato Collection (CPC) of wild and cultivated species from Latin America which can be used for these purposes. The collection has already proved a useful source of genes for resistances to late blight, viruses and potato cyst nematodes which were lacking in the European potato. It was also used to widen the genetic base of breeding programmes from the cultivated species of South America through the creation of broad based populations of long-day adapted germplasm which displayed hybrid vigour in crosses with our European potato. However, relatively few wild species and relatively few clones from the long-day adapted populations have been used to any extent in the breeding of modern cultivars. We are keen to make better use of the CPC and will continue to screen the CPC for desirable traits and undertake genetic studies on their inheritance, followed by the introgression of desirable genes into our European potato. These approaches will be supplemented by an increased understanding of the biodiversity present in the CPC which will be provided by our colleagues from their molecular marker and DNA sequence data. SCRI will then use modern molecular breeding methods to increase the speed and efficiency of new introgressions. Initially these will involve molecular marker assisted selection but gene cloning should certainly not be ruled out for the future, and indeed is being pursued in a number of laboratories worldwide.



Genetical knowledge

As genetical knowledge accumulates, we will be able to choose parents that have desirable genes and then select for these in their offspring. At SCRI, a modern genomics programme is contributing to this increase in genetical knowledge. If the Dutch led consortium to sequence the whole potato genome progresses as planned, SCRI will participate, and by 2009 we will have genetical knowledge undreamed of in 1990, when the first genetical maps of potato became available. For those economically important characteristics which may still have to be handled as complex traits, SCRI has developed a potato breeding strategy based on progeny testing which avoids the common but ineffective practice of intense early-generation visual selection between seedlings in a glasshouse and spaced plants at a seed site. Furthermore, it allows recurrent selection to be operated on a three year cycle, an improvement on the practice of not using potential cultivars as new parents until they are entered into official National List Trials.

Genetically modified potatoes

Finally, in future, we expect that our successful cultivars will be genetically modified to introduce genes not present in cultivated potatoes and their wild relatives in order to achieve further major improvements in yield, quality and resistance to abiotic and biotic stresses. The technology is currently being used for research purposes at SCRI but could be extended to produce genetically modified potato crops once consumers see the benefits and they become acceptable in the European Union.

Acknowledgements

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