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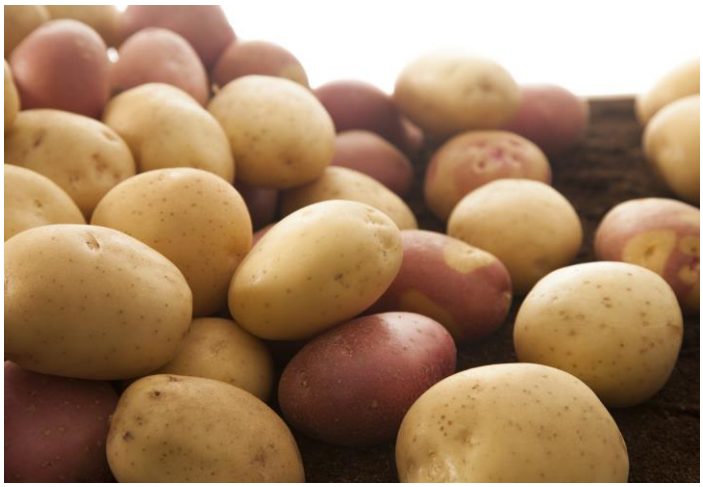
Funding source: IPM Potato Group Ltd **Project dates:** July 2012 – Oct 2018

Potato Breeding



Key external stakeholders:

IPM Potato Group project partners.
Potato growers, consumers, fresh retail and processing sectors.

Practical implications for stakeholders:

- The development of new potato varieties is a lengthy process taking over twelve years from crossing to the release of a new variety. New varieties must have good appearance and taste characteristics to satisfy consumers and retail outlets to be successful. Tighter margins for growers coupled with the need to reduce pesticide and fertiliser inputs require new sustainable high yielding varieties with increased disease resistance. In developing countries, consumption of potato is increasing rapidly with consequent demand for new improved varieties. In the western hemisphere fresh consumption is falling and there is a greater demand for potato varieties suitable for processing. Improved varieties remain the most cost effective and environmentally sustainable way to improve yields and combat certain diseases and pests which contributes to competitiveness.

Main results:

- Between 2002 and 2018 the potato breeding programme has released 22 varieties for diverse markets/sectors such as pre-packing, baking, Mediterranean export and crisping.
- The use of marker assisted selection (MAS) as a novel breeding tool has greatly improved the efficiency of selection for new potato varieties with enhanced resistance to pests and diseases.

Opportunity / Benefit:

Potato based industries and activities are underpinned by specific varieties exhibiting sets of characteristics that match them to their end-use. Many markets are dominated by older, established varieties that, while familiar, may lack desirable agronomic and consumer oriented characteristics. New varieties with enhanced consumer traits and novel disease and pest resistance offer market growth and sustainable, more environmentally friendly production regimes which benefit all stakeholders and consumers of potato.

Collaborating Institutions:

IPM Potato Group Ltd

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Teagasc project team: Dr. Denis Griffin PI, Dr. Dan Milbourne, Mr Colum Kennedy, Ms Jeanne Moore, Ms Francesca Mesiti, Mr Greg Deering, Mr Martin Brennan, Ms Fiona Hutton, Ms Claudia Miranda Cekalovich, Mr Andy Bourke, Dr Marialaura Destefanis, Dr Emmet Dalton, Dr Brian Rigney, Dr Joseph Mulhare

External collaborators: Mr Colm McDonnell
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1. Project background:

Teagasc has been breeding new potato varieties since 1962. Originally, the programme focused exclusively on breeding for the Irish market but during the 1970s a partnership was formed with Irish Potato Marketing (IPM) which continues to this day and expanded the scope of the programme to breed for export markets. Forty-seven varieties have been released in the intervening period to 2018 with over 30 of these still being marketed commercially by IPM. The relationship with IPM has been governed by four different contractual periods the latest of which began in 2019. This technical update reports on the variety outputs from the third contractual period from 2002-2018.

Rooster is by far the best known of these varieties in Ireland and now accounts for over 60% of the total potato area (approx. 9,000 ha in 2017) grown in Ireland. Cara was the first successful variety released and is still popular in the UK and some Spanish regions. Nectar has steadily grown from its release in 2005 and is now one of the most popular potato varieties in the UK and fourth largest variety there in 2018 (3,670ha). Varieties such as Banba, Burren, Electra and Tornado are currently the most widely marketed varieties, with seed produced in North Western Europe exported to over 40 markets mainly in southern Europe, North Africa and the Middle East. Presently, Teagasc varieties are being grown as far afield as Australia and Brazil. The breeding programme at Oak Park releases 1-2 varieties per year with twenty two released between 2002 and 2018 (see attached table). These new varieties are becoming established in both traditional and new markets. The potato breeding programme in Oak Park is self-sufficient due to funding and royalties from seed sales provided by IPM Potato Group. The relationship with IPM potato group has been an excellent example of public private partnership.

2. Questions addressed by the project:

The project set out to breed high yielding commercially successful varieties with enhanced consumer attributes and high levels of disease resistance. The project has also endeavored to develop and adopt new technologies to enhance the delivery of new varieties through several PhD projects. During this period marker assisted selection has become an integral part of the breeding program allowing selection of seedlings with resistance to late blight, potato wart, potato cyst nematode and potato virus Y. In addition, genomic selection for processing and storage traits has been evaluated for use through collaboration with other projects (See tech update 6789).

3. The experimental studies:

It takes approximately 12-14 years to breed a new potato variety from initial crossing to release of the finished/named variety. Fig 1 outlines the current timescale and numbers of seedlings involved in the programme. The Teagasc programme is typical of the size and scale of similar medium to large sized breeding programs in Holland and Germany where potato breeding activity is most intensive. Seedling numbers are gradually reduced each year while the remaining seedlings are evaluated rigorously for more traits in each successive generation. Marker assisted selection (MAS) is now being used extensively at the Year 4 stage, enabling routine early selection for potato cyst nematodes (PCN), late blight, potato virus Y and potato wart disease. In addition to the routine use of MAS in the programme, a separate molecular marker-driven experimental breeding program was established, and this enabled the development of a large number of breeding lines exhibiting multiple disease and pest resistances. These lines were incorporated into the main programme, allowing the rapid selection of multi disease resistant parents from years 5, 6 and 7 of the breeding programme. The combination of these MAS initiatives has led directly to an increase in the number of highly resistant seedlings currently being considered as candidate varieties with many in national list trials that will be released in the next potato breeding project. Seedlings from year seven upwards are trialled at multiple locations in Ireland, The UK, The Netherlands and France as well as north Africa and the Mediterranean region, with increased emphasis being placed on processing and storage quality.

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4. Main results:

Table 1: Varieties released by Teagasc between 2002 and 2018 including relevant grants of plant breeders' rights in Ireland, Europe and the date of expiry of plant breeders' rights. For a detailed description of each of the following varieties and their end uses please visit https://ipmpotato.com/varieties/

No	Variety	Irish PBR Grant No	Grant Date	EU PBR Grant No	Grant Date	Breeders reference
1	Camelot	379	01/04/2003	EU13124	19/04/2004	T1583/73
2	Kikko	386	01/01/2004	EU14421	06/12/2004	T1670/19
3	Setanta	387	01/01/2004	EU14420	06/12/2004	T1823/10
4	Galactica	378	11/11/2004	EU13892	13/09/2004	T1399/17
5	Habibi	389	11/11/2004	EU16882	13/02/2006	T1543a92
6	Carnaval	391	14/07/2005	EU18728	04/12/2006	T958/7
7	Nectar	390	14/07/2005	EU18015	03/07/2006	T1903/48
8	Savanna	393	14/02/2006	EU19305	05/03/2007	T1544/6
9	Electra	402	03/12/2007	EU23619	13/10/2008	T2704/1
10	Romeo	401	03/12/2007	EU23620	13/10/2008	T2637/12
11	Cristina	413	18/11/2009	EU28070	06/09/2010	T3747/13
12	Infinity	412	18/11/2009	EU28069	06/09/2010	T3302/3
13	Torino	420	14/11/2011	EU34049	21/01/2013	T3537/2
14	Bikini	421	26/06/2012	EU36235	23/09/2013	T2345/1
15	Casino	422	25/05/2013	EU37803	05/05/2014	T2516/15
16	Tornado	423	05/03/2014	EU39109	03/11/2014	T3983/1
17	Fandango	424	16/05/2014	EU39223	18/12/2014	T3039/38
18	Imagine	425	26/11/2014	EU41781	05/10/2015	T4679/12
19	Gravity	429	23/05/2016	EU44959	05/12/2016	T5049/9
20	Antarctica	428	23/05/2016	EU44960	05/12/2016	T5014/1
21	Vanilla	431	19/12/2016	EU47696	09/10/2017	T5339/12
22	Alibaba	430	19/12/2016	EU47697	09/10/2017	T4906/2

5. Opportunity/Benefit:

The varieties listed in the table above target a diverse range of markets and climatic conditions where they offer advantages over many of the incumbent varieties and offer considerable growth opportunities. Varieties like Electra and Tornado offer particularly wide environmental adaptation and can be grown in many different countries. The development and deployment of marker aided assisted selection has modernised the breeding programme and will contribute to the production of commercially successful sustainable disease resistant varieties which will benefit the entire potato production and value chain.

6. Dissemination:

Main publications:

Rigney B., Blok V., Griffin D., Dalton E., Cave C., & Milbourne D. 2017. Pyramiding two partially effective loci conferring resistance to *Globodera pallida* Pa2/3 act consistently across multiple nematode field populations. *Plant Pathology*.66, 1031-1040.

Destefanis, M., Nagy, I., Rigney, B., Bryan, G. J., McLean, K., Hein, I., Griffin, D., & Milbourne, D. (2015). A disease resistance locus on potato and tomato chromosome 4 exhibits a conserved multipartite structure displaying different rates of evolution in different lineages. *BMC plant biology,* 15(1), 255.

Wesemael, W. M., Anthoine, G., Griffin, D., Holgado, R., & Ollivier, F. (2014). Quarantine Nematodes in Potato: Practical Solutions Using Molecular Tools. *Potato Research,* 57(3-4), 365-366.

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Dalton, E., Griffin, D., Gallagher, T. F., de Vetten, N., & Milbourne, D. (2013). The effect of pyramiding two potato cyst nematode resistance loci to *Globodera pallida* Pa2/3 in potato. *Molecular breeding,* 31(4), 921-930.

Andrivon, D., Avendaño-Córcoles, J., Cameron, A. M., Carnegie, S. F., Cooke, L. R., Corbière, Detourné D., Dowley, L.J., Evans, D., Forisekova, K., Griffin, D., Hannukkala, A., Lees, A.K., Lebecka, R., Niepold, F., Polgar, Z., Shaw, D.S., Thompson, J., Trognitz, B., van Raaij H.M.G. and Zimnoch-Guzowska E. (2011). Stability and variability of virulence of *Phytophthora infestans* assessed in a ring test across European laboratories. *Plant Pathology,* 60(3), 556-565.

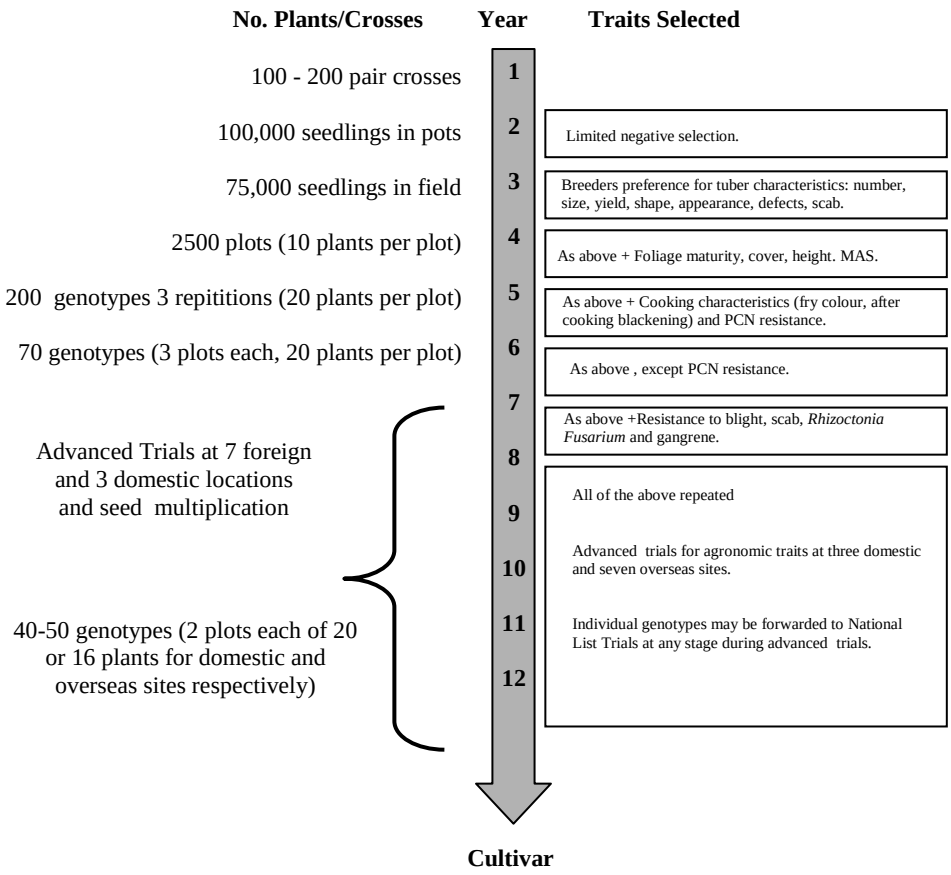
Moloney, C., Griffin, D., Jones, P. W., Bryan, G. J., McLean, K., Bradshaw, J. E., & Milbourne, D. (2010). Development of diagnostic markers for use in breeding potatoes resistant to *Globodera pallida* pathotype Pa2/3 using germplasm derived from *Solanum tuberosum ssp. andigena* CPC 2802. Theoretical and applied genetics, 120(3), 679-689.

Popular publications:

Byrne, S., Griffin, D., and Milbourne, D. 2016 GenSPI: Genomic Selection for Potato Improvement. *TResearch*, Vol. 11. No.2. pp 34-35.

7. Compiled by: Denis Griffin & Dan Milbourne

Fig 1: Outline of Potato breeding Program at Oak Park



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