

Field trial of late blight resistant potatoes

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Defining the problem

What is late blight and why is it important?

A: Since late blight [Phytophthora infestans] first ravaged potato crops during the 19th century Irish potato famine, this disease has been a major threat, causing enormous economic damage in potato and tomato. Globally, potato late blight causes about £3.5 billion annual losses. In the UK, potatoes are currently planted on about 130,000 ha, yielding ~ 6m tonnes of potatoes with a farm gate value of around £600m. It costs ~£350/hectare to control late blight. In a typical season, UK potato farmers spray fungicides 10-15 times to reduce losses to blight. However, this does not completely prevent crop losses and has an associated negative impact on the environment due to the chemicals released to the environment and the CO₂ emissions from tractors used to apply the sprays. Growing blight resistant crops will greatly reduce crop losses to the disease and reduce the number of fungicide sprays required, thereby having both economical and environmental benefits.

Aren't blight resistant varieties of potato already available?

A: Yes, but the more blight resistant varieties are not widely accepted in the market because of other deficiencies. Also, the pathogen [disease-causing organism] that causes blight is constantly changing, and strains of the pathogen that are able to overcome resistance in the most commonly grown potato varieties are now prevalent in the UK. Importantly, one of the new genes we have identified confers resistance to this strain.

We can never have 'too many' resistance genes available for use.

Why do these potatoes need to involve GM technology rather than being conventionally bred?

A: Potato breeding is extremely slow and inefficient. It is better to take a good variety like Maris Piper (25% of the market) and enhance its blight resistance than to try to breed a blight resistant Maris Piper. Breeding is not an exact science and changes many genes that affect important agronomic traits such as yield, quality and maturity time. By using GM we can be sure that only the desired resistance gene is introduced into the resulting variety, without changing other characteristics.

Who is providing the funding for the trial? Is there any commercial funding?

A: The trial is funded by the UK's Biotechnology & Biological Sciences Research Council (BBSRC). BBSRC funds and supports the use of GM as a laboratory tool and research to investigate the feasibility of producing GM crops with specific beneficial traits. No commercial funding is involved.

The solution

What genes have been used to create the GM potatoes?

A: Two genes that give potatoes resistance against the pathogen have been isolated from wild South American potato species. The wild South American species are not edible potatoes and are not suitable for cultivation in Europe or elsewhere.

*In addition to well characterised laboratory races, we also know that one of the genes is effective against the race of *Phytophthora infestans* that was prevalent in the recent serious UK epidemic years of 2007 and 2008 (known colloquially as 'superblight' or Blue 13).*

The potatoes also contain a gene which confers resistance against the antibiotic kanamycin. Kanamycin is used during the genetic modification process as a means to select plant cells that also contain the inserted resistance genes. This antibiotic is not used for medical treatment of either humans or animals.

*One of the *Rpi* genes (**R**esistance to **P**hytophthora **i**nfestans genes) was isolated from a wild species using two successive BBSRC grants. The other was isolated partially with BBSRC and partially with EU funding.*

Are the products of the genes toxic?

A: No, not even to the late blight pathogen. The resistance genes give the plants the ability to recognise strains of the late blight pathogen that they are normally unable to recognise. In effect, the presence of these genes "immunises" the plant against the disease. Following recognition, the plant's own in-built defence mechanisms then prevent the pathogen from growing further and causing disease on the plants. The product of the kanamycin resistance gene has also been shown to be non-toxic to humans and animals.

The tubers produced by the potato plants in this trial will be destroyed following harvest and will not enter the human or animal food chain.

What would you say in defence to those who think GM trials should not be carried out?

A: Our approach has a high likelihood of helping to minimise the impact of agriculture on the environment by reducing applications of fungicides for late blight control.

BBSRC supports, and has full confidence in, the UK regulatory framework for research on GM crops. This is particularly the case when scientists are working to provide objective evidence about some of the potential benefits that are seen by some as contentious.

What is the point in carrying out this research when there has been no take-up of GM products in the UK so far?

A: BBSRC funds basic plant science that underpins a range of farming systems, including organic and low-intensity farming. While GM is a powerful tool and offers significant potential it may not be the most appropriate way to tackle some problems, but in other cases it may be the only feasible option for introducing particular traits.

We believe that the scientific challenges in feeding a growing global population places a responsibility on us, as publicly funded researchers, to investigate thoroughly all potential ways that bioscience and biotechnology might be used to increase food production sustainably – including, for example, GM in breeding and natural bio-agents in pest and disease control.

What are the potential benefits of the potatoes? Is it in the end just more profit for farmers? Or is this just about making food even cheaper for supermarkets?

A: The goal of the trial is to assess if this approach to enhancing crop disease resistance is likely to be successful. If it is successful, and if the approach can be deployed widely, there will be a reduced impact of potato cultivation on the environment because of reduced need to apply agrichemicals. This benefits everyone; consumers as well as farmers.

Why in Norfolk?**Why does the trial have to be in Norwich?**

A: The trial is being conducted by leading UK scientists working on plant disease and plant disease resistance at The Sainsbury Laboratory on Norwich Research Park. The scientists want the trial to be conducted in closely supervised conditions, with top-quality support, where they can easily monitor the outcome.

What is the Sainsbury Laboratory at the John Innes Centre?

A: The Sainsbury Laboratory (www.tsl.ac.uk) was set up in 1988 to better understand biological interactions between plants and microbes. It was established as a joint venture of John Innes Centre, UEA, BBSRC and the Gatsby Charitable Foundation (see <http://www.gatsby.org.uk/>), one of David Sainsbury's private charities, and receives generous core funding from Gatsby. In addition to Gatsby funding, the lab wins grant funding by submitting competitive grant proposals to BBSRC, EU and other public bodies. The Lab has no interaction with J Sainsbury Plc.

Have local residents and farmers been informed?

A: Notification of intent to carry out the trial appears in the Daily Telegraph issue of 11 February 2010. We have also put details on The Sainsbury Laboratory website. Local councils, key public bodies and local media have been informed. The National Farmers Union has been informed.

There are farms and residential areas nearby – do people need to be worried about GM material escaping and crossing with their crops and plants?

A: The pollen from potatoes does not travel significant distances, typically less than 10 metres. Potatoes cannot cross with any other naturally occurring species. In the extremely unlikely event that the GM potatoes did cross with cultivated potatoes, any seed produced would not be saved as potatoes are grown from tubers. The pollen itself does not pose a threat to humans or other animals.

What extra security measures will be in place?

A: The area of the trial will be surrounded by a high fence and is on private land.

The research council funding this work, BBSRC, strongly condemns individuals or groups that seek to disrupt or damage legitimate scientific trials. This activity wastes public money and denies public and policymakers access to important scientific evidence.

Have Norfolk police been informed so they can prepare for any potential vandalism?

A: BBSRC believes, and we agree, that scientists should be able to conduct legitimate, publicly funded research on GM plants free from the threat of interference. Yes, the police have been informed.

How long will the trial last?

A: Three years.

What size will the plot be?

A: The total area dedicated to the field trial is approximately 1000 square metres. Each year of the trial, approximately 200 square metres will be sown with the GM potatoes. Two GM potato lines will be sown; no more than 200 plants of each line will be sown each year of the trial.

Why can't the trial be carried out in a glasshouse?

A: We have done glasshouse trials and we now need to know if the resistance works in the field.

Resistance will be tested against the naturally occurring populations of Phytophthora infestans. The only way to see if the potatoes resist the blight race diversity circulating in nature is to conduct a trial outside

The future

Who will own the rights to any commercial discoveries / crop products?

A: The rights are owned by The Sainsbury Laboratory and handled by Plant Bioscience Ltd, the Sainsbury Laboratory's IP management company. The rights for one of the genes are shared with Wageningen University, The Netherlands.

Do the inventors stand to make money?

A: If the technology proves useful, is licensed and is commercially deployed, then the TSL Rewards to Inventors scheme means that the inventors will share in some of the royalties with the laboratory.

Will the results be made publicly available?

A: Yes; results will be peer-reviewed and published in scientific journals.

What will happen to the potatoes at the end of the trial? Will all traces of GM material be removed from the site after the trial?

A: All potatoes from the trial will be dug up, tested for disease and then heat-treated to destroy them. All plant material will be removed from the site after the trial. No potatoes will be grown on the release plot for two years following the trial.

What will the next stage be – when and where could they be grown commercially?

A: Farmers are keen to be able to deploy blight resistant varieties. Once consumers see that this technology confers great benefits to the environment, we hope that supermarkets will stock some form of GM blight resistant potatoes and offer this choice to consumers.

Would future GM blight resistant potatoes be available to the domestic grower or simply be held by one 'supergrower'?

A: The potatoes being grown in this trial will not be available commercially. The purpose of this trial is to test the efficacy of the blight resistance genes. Should this trial be successful we hope that companies will want in the future to licence the genes and deploy them in commercial crops.

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