Objecting to an application to trial GM Potatoes in Yorkshire

Summary

This briefing provides details of an application to release GM potatoes in Yorkshire and sets out grounds for objecting. The deadline for objections is 3 March 2008. Page 4 of this briefing sets out the case for rejecting the application to grow GM spuds in Yorkshire.

Background

The Centre for Plant Sciences at the University of Leeds has applied to Defra to conduct field trials of GM potatoes engineered to repel the potato cyst eelworm or potato cyst nematode (PCN) or eelworm. They have applied for a Part B Consent for experimental release under the Genetically Modified Organisms (Deliberate Release) Regulations 2002[i].

The trials would commence in spring 2008, run from April to November, and continue for 5 years until 2012. They would take place at the Leeds University Farm at Tadcaster, North Yorkshire, covering not more than 1,000 square metres and would involve planting fewer than 4,000 GM plants per year.

The applicants state their objective of the trials as:

> 1a. To demonstrate the long term potential of biosafe novel resistance as a basis for control of potato cyst nematodes that replaces dependence on pesticide based control or the hidden costs of non-optimal cultural control
> 1b. To demonstrate that such approaches are fully biosafe and environmentally benign
> 2c. To demonstrate field efficacy for defences that have the ability to protect many crops from nematode pests
> 3d. To demonstrate efficacy and biosafety before transfer and donation of the approach to other crops in international projects in both Africa and Asia that aim to suppress nematode damage to subsistence crops. Nematodes cause an estimated untaken harvest in African alone that is sufficient to feed 50 million people.

This is a publicly funded project with £1.7 million from the Biotechnology and Biological Sciences Research Council (BBSRC)[ii]. The University of Leeds is working with the Welcome Laboratory Sangar Institute and the Scottish Crop Research Institute.

Potato Cyst Nematode

Potato Cyst eelworm (PCN) is a nematode which attacks the roots of potatoes, reducing their yields. Losses can be very serious and depend on the severity of the infestation. Nematodes are thread-like worms commonly found in soil in the millions per square metre. Most nematode species are harmless to plants and are considered to be a vital part of the soil ecology and processes.

There are two species of PCN in the UK: *Globodera rostochiensis* (yellow PCN) and *G.pallida* (white PCN), *G.pallida* being most common. Both form bead-like growths on the roots of potatoes distinguishable by their initial colour. Later in the life cycle both species turn reddish brown. Infestations become established from mid-July to mid–August and result in yellowing and wilting of foliage. Current controls (using pesticides and resistant varieties) have encourage farmers to

shorten their rotations and grow potatoes more frequently. This has led to *G.pallida* becoming more common. Farmers are further encouraged by the superior gross margins arising from potato crops compared with other arable crops[iii].

PCNs survive in the soil as cysts and can remain viable for 10 years or more. There may be as many as 25 million cysts per hectare in a badly infected field. Cysts can be spread about in soil on harvested potatoes, on other root crops, on equipment, on vehicle tyres and on footwear. In light or peaty soils wind and water erosion can transport cysts from field to field as well.

Infestations of PCN can be predicted by monitoring soil in advance of planting.

When the cysts hatch, stimulated to do so by chemicals exuded by potatoes, between 200-600 larvae are released in the soil. If the larvae fail to find a potato root they eventually die. Potato crops can cope with low level infestation, but yield losses are considerable if large numbers of females invade the roots.

GM Potatoes

The GM potatoes have been modified to produce chemicals called cystatins which repel female PCN from invading the roots. The applicants for the GM potato trials say that cystatins are not toxic to PCN but prevent infestation taking place.

The cystatin-producing gene involved in the genetic modification comes from rice (it has one amino acid removed). The other nematode-repellant genes are described in the application as "synthetic".

Other genes used in the novel constructs are promoters from Thale cress (*Arapidopsis thaliana)* and cauliflower mosaic virus, *Agrobacterium tumifaciens* (terminator sequence[1]), and *Nicotinia plumbaginifoli* (signal sequence).

The potatoes also include an antibiotic resistant marker gene resistant to Neomycin. Although this group of antibiotic resistant genes is approved by the European Food Safety Authority (EFSA) for use as markers in GM crops, the European Medicines Agency has challenged EFSA's opinion because of the potential importance of this group of antibiotics in medicine[iv].

The genetically modified potatoes are the variety Desiree, which is known to consistently produce flowers, pollen and fruit (known as berries).

Previous trials of the GM potatoes did not produce complete protection:

> *In a field test, the best lines of potato cvs Désirée and Sante transformed to express the cystatin provided > 70% and 85% resistance respectively, relative to the untransformed cultivars. However, when transformed Sante was exposed to a virulent* G.pallida *population, the level of control declined to 51%. In more recent tests, transformed lines of Sante had improved resistance to* G.pallida *and the best line prevented populations of the nematode increasing [16]. In a similar approach, a cystatin gene from the tubers of potato cv. Jersey Royal has provided significant control (60%) of* G.pallida *populations when expressed in the roots of the same cultivar).*[v]

Current Control Measures

At present PCN is largely kept under control by the use of good hygiene, crop rotations, pesticides and using potato varieties which exhibit natural resistance. Fewer varieties exhibit resistance to *G.pallidia* than *G.rostochiensis.* It is illegal to grow seed potatoes on land infested with PCN[vi]. In Northern Ireland growers are prohibited from growing potatoes on PCN infested land.

[1] NB this is not Terminator technology designed to produce sterile seeds

The use of pesticides to protect crops against PCN accounted for 14% of applications insecticides and nematicides usage according to the latest pesticide usage survey (2006) for ware potatoes[2] (57% by weight). It is reported that just 1% of the area grown was treated with the nematicidal pesticide 1,3 dichloropropene to control the pest. This represented 256 tonnes of the product or 0.2 tonne /ha.[vii] Approval for the continued use of Aldicarb (Bayer's *Temik*) to control PCN was withdrawn in 2003 and is completely banned from 2008. Three other granular nematicides are approved for use in the EC.

Alternatives to GM for Controlling Cyst Eel

The follow measures can be used in combination to minimize the threat of yield loss due to PCN and negate the need for GM potatoes:

Good hygiene To reduce the spread of PCN cysts, potato clamps should be made on the land which had grown the crop. Soil from potato washing should only be tipped on the land used to grow the crop. Machinery and vehicle tyres should be cleaned of soil deposits as far as possible, especially if shared between farms. Hedgerows around fields should be maintained with good cover close to the ground to trap eroding soil. Sowing green manure ground cover will reduce the risk of erosion.

Good Husbandry Soil should be tested for PCN before planting. Potatoes should not be planted in PCN contaminated land, and should be rotated with a minimum period of 5 years between crops, preferably longer if possible. Only certified seed potatoes should be used if PCN is present on the farm or area. Lightly contaminated land should only be used as a last resort. The number of tubers lifted at harvest should be maximised, and groundkeepers (potatoes left in the ground after harvest and which re-grow in the following season) dealt with promptly and effectively. Good management of the soil to encourage a rich and diverse populations of micro-fauna and flora to make it nematode "suppressive" by encouraging predators and parasites of PCN can exert control after a number of crop cycles[viii].

Select Resistant Varieties If land is contaminated with a low level of PCN, a resistant main crop variety should be selected, or early or second early varieties, which are harvested before the cyst eelworms start to multiply. The current British Potato Council Potato Variety list[ix] includes 30 (out of 172) varieties exhibiting some degree of resistance to PCN (17.5% of varieties with some degree of resistance), mostly for *G.rostochiensis.* Very susceptible varieties (often the older ones) should be avoided - 19 susceptible varieties are on the current variety list as "susceptible", although not all have been tested.

Future Developments

Many different ways to control PCN have been researched apart from the GM. Some are more promising than others. A Rothamsted Research report for Defra in 2003 listed the possible methods[x]:

- Antagonistic rhizobacteria
- Bacterial parasites
- Nematode-trapping fungi
- Fungi with adhesive spores
- Pathogenic fungi
- Bioactive compounds
- Trap crops, eg potatoes **or** non-tuber-forming *Solanum* species (the potato family)
- Isothiocyanates created by incorporating Brassicas into the soils
- Chemicals which stimulate hatching pf PCN
- High frequency electrical fields
- Microwaves
- Soil exposed to strong sunlight

[2] Potatoes grown for food

Concerns about the Current Trial Proposals

GM Freeze does not believe that the outdoor GM potatoes resistant to cyst worm can be justified at present:

Not in the interests of sustainable farming

If commercially grown these GM potatoes may well encourage farmers to grow main crop potatoes on a much shorter rotation. This would not be in the interests of sustainable farming because it would:

- increase the risk of soil erosion (the bare soil in potato crops is prone to water and wind erosion)
- increase the risks of other potato pests and diseases (which number 600 in the UK) with a possible increase in pesticide use
- reduce soil nutrients leading to increased use of artificial fertilizers.

The applicant will use this trial to assess the impact of the cystatins produced by the GM potatoes on other beneficial soil nematodes. GM Freeze believes that this research can be carried out in controlled conditions in greenhouses, without the risk of GM pollen passing to surrounding crops and with greater chance of controlling groundkeepers left in the soil.

The applicants appear to have assumed that the UK PCN species will remain susceptible to the repelling effect of cystatins in perpetuity. GM Freeze is concerned that the continuous presence of cystatins in potato root zones would lead to resistance in PCN developing over time. This would be a particular concern if PCN-repellant potatoes were grown regardless of pest levels being low and without a long rotation between crops.

Risk of contamination

GM Freeze is also concerned that there are no proposals to limit pollen and berry production by removing any flowers from the crop, or to establish a separation distance to the nearest non-GM potatoes reflecting the distance that pollen has been shown to travel.

Distances for potato to potato cross-pollination events of up to 1km have been recorded in which pollen beetles were believed to be the vector.[xi] Pollination is by insects including bumble bees, hover flies and pollen beetles (probably the most important). Long distance cross-pollination events have been found to occur. Potatoes do not cross with close relatives very easily. Although there is no evidence to date that this has occurred in the field, two relatives (black nightshade and woody nightshade) commonly grow in farmland, and the potential for rare cross-pollination events in the field cannot be ruled out. The discovery of GM charlock (an oilseed rape relative) following Farm Scale Evaluations provided some evidence that rare and improbable pollination events can and do occur. Their long term significance is very hard to judge without more knowledge of the likelihood of such events taking place.

It is important to note that if a non-GM potato flower was cross-pollinated by GM potato pollen the tuber of the non-GM variety would still be non-GM. Only the seed would contain GM material. Not all potato varieties flower and produce pollen. Some drop their flowers before fertilization. Others produce fruit (berries), but without viable seeds. Some produce fully fertile seed in their berries from which it is possible to grow new plants (Desiree being the best example of this from the commercially popular varieties).

Antibiotic resistant gene

The presence of the antibiotic resistant gene (resistant to neomycin) is a major worry. GM Freeze believes that the gene is unnecessary for the trial and should be removed.

Food safety

Finally, the applicants have failed to address the food safety aspect of the genetically modified potatoes (aside from the apparent lack of mammalian toxicity of cystatins). They make no

reference to the possible allergenicity of this protein in the form that would be present in the GM potato. Before development of these GM potatoes progresses any further, well designed allergenicity tests should be carried out.

Firstly, cystatins have been found to be allergens (eg kiwi and cat).

Secondly, the lack of allergenicity of a compound produced in one organism does not guarantee the absence of allergenicity of this compound when produced in another organism. The possibility of the allergenicity of GM protein changing as a result of genetic engineering events was well demonstrated by research on bean alpha amylase proteins when genetically engineered into peas. Researchers found the allergenic reactions occurred in mice fed the GM peas, but not when fed non-modified peas or the parent non-GM beans[xii].

Other food safety concerns arise because of the unpredictable outcomes of genetic engineering events in addition to the toxicity and allergenicity of GM proteins produced. There are at least two examples where experimental GM potatoes produced entirely unpredicted outcomes in the parent:

- The first was a potato modified to have low levels of the NAD-malic enzyme. This modification had the surprising effect of increasing the potatoes starch content - an outcome the research team was unable to explain[xiii].
- The second example comes from Germany, when an attempt to introduce a yeast gene to increase starch content had the opposite effect and several unexpected compounds were formed by the disruption caused to the metabolism[xiv].

In addition, research on GM potatoes modified to produce an insect toxin was published in 1999[xv]. This research suggested a link between feeding GM potatoes and damage to the immune system and growth rates of rats. This research provoked much scientific controversy[xvi] at the time, but no follow-up research has ever been carried out.

The applicant does not provide any evidence to show it has looked for such unexpected events in their GM potatoes or safety data. However it should be noted that it is intended that the GM crop will be destroyed at the end of each trial. Expert analysis of the GM construct and surrounding DNA may produce other issues of concern.

There is little point in field testing a crop for five years only to find that it fails the risk assessment for food and feed safety during any application for commercial release.

How Can We Object?

There are a number of grounds for objecting to the GM potato trials proposed by Leeds University:

- There is no demand for GM potatoes now or in the immediate future, and therefore the trials represent an unnecessary risk to the environment and the integrity of the GM-free potato supplies in the UK.
- There is no need to use GM for potato cyst eelworm repellant potatoes because conventionally bred resistant varieties are already available which, if used in combination with long rotations and good hygiene, can minimize yield losses. It is unclear how the introduction of GM PCN repellant potatoes will fit in with other sustainability objectives for farming, as they may lead to shorter rotations and increase risk of pollution, soil erosion and pest and disease build up.
- There is a risk the pollen could be transferred by insects to crops in the vicinity, and the resulting GM seeds could germinate to contaminate future non GM crops.
- GM groundkeepers (volunteers) could persist in the field for a number of years, certainly into a subsequent potato crop in the rotation.
- Small GM tubers could be transferred by machinery or even wild mammals off field to reestablish feral populations.
- No evidence is provided that unexpected side effects of the GM insertion have not taken

- place, or that there is any data available on the food safety of the GM potatoes apart from toxicity report for cystatins.
- The applicants make reference to synthetic repellant genes but provide no data to support their safety.
- The presence of the neomycoin resistant gene raises concerns about the long term risk of increasing antibiotic resistance in pathogenic bacteria should the GM potato receive commercial approval. It should be removed.
- The applicant should demonstrate that they have proven that the GM proteins in the potatoes have not developed allergenicity as a result of the genetic engineering events before the experiment proceeds.

Deadline for objections 3rd March.
If the trial goes ahead, Defra can place conditions on the release consent that would reduce the risk of any GM materials escaping or gene flow taking place. The conditions could include:

- No other potatoes should be grown on the site for the duration of the experiment
- All potatoes in the trial should be destroyed on site regardless of whether they are GM or not
- A prohibition on future potato crops on the same land for 10 years
- A requirement to monitor and control groundkeepers for 8 years
- A requirement to remove flowers prior to pollination
- A separation distance of 1.5 km between the trial and the nearest non-GM potato crop, including those grown in allotments or gardens
- Fencing to prevent wild mammals entering the site, and
- Removal of the antibiotic resistant marker gene.

If you wish to object to the application, quote application reference number 07-R31-01 and write to:

The GM Team
Department for Environment, Food and Rural Affairs
Area 4D
Nobel House
17 Smith Square
London SW1P 3JR

or email gm-regulation@defra.gsi.gov.uk

[i] www.defra.gov.uk/environment/gm/regulation/applications/07-r31-01.htm
[ii] http://reporter.leeds.ac.uk/press_releases/current/nematode.htm
[iii] www2.defra.gov.uk/research/Project_data/More.asp?I=HH3111TPO&M=CFO&V=IACR
[iv] www.emea.europa.eu/pdfs/human/opiniongen/5693707en.pdf
[v] Kerry B, et al, 2003, *Investigations into Potato Cyst nematode Control,* Rothamsted Research, Defra Contract HH3111TPO , see http://www2.defra.gov.uk/research/Project_data/More.asp?I=HH3111TPO&M=CFO&V=IACR
[vi] Statutory Instrument 1993 No. 1320 The Plant Health (Great Britain) Order 1993
[vii] www.csl.gov.uk/newsAndResources/resourceLibrary/articles/puskm/arable2006.pdf, p78
[viii] Kerry B, et al, 2003*, op cit*
[ix] http://varieties.potato.org.uk/varietyindex.php%20?page_no=1
[x] Kerry B, et al, 2003, *op cit*
[xi] www.soilassociation.org/web/sa/saweb.nsf/b0062cf005bc02c180256a6b003d987f/e502ce130dc0df3d802571cd004eb285!OpenDocument&Highlight=2,emberlin
[xii] www.pi.csiro.au/GMpeas/PI_info_GMpeas.pdf
[xiii] 2 BBSRC Business, Jan 1998, “Making crops make more starch” p6-7
[xiv] Gura, T, 2000, Science 287, “Reaping the plant gene harvest” p412-414
[xv] Ewan, SWB & Pusztai, A, 1999, The Lancet 354: 1353-1354, *Effect of diets containing genetically modified potatoes expressing* Galanthus nivalis *lectin on rat small intestine*
[xvi] The Royal Society, 17 May 1999, *Review of data on possible toxicity of GM potatoes*