

GENETICALLY MODIFIED ORGANISMS (P.33/99): REPORT

**Presented to the States on 14th September 1999
by the Agriculture and Fisheries Committee**



STATES OF JERSEY

STATES GREFFE

175

1999

P.33/99 Rpt.

Price code: C

GENETICALLY MODIFIED RESEARCH ASSOCIATED WITH THE JERSEY ROYAL POTATO

Summary

The Agriculture and Fisheries Committee has reviewed the background to Genetically Modified Research and the Jersey Royal potato. It has also visited Rothamsted Research Station to see work in progress and to discuss at first hand with those who are involved not only with work on the Jersey Royal potato but also on modifying other crops. In addition the Committee has, of course, been aware of the ever-increasing consumer resistance to genetically modified crops. The Committee has also been made aware of growers' fears that adverse publicity might well damage the future profitability of the Jersey Royal potato. Finally the Committee note that the EU itself is now applying a cautionary approach to the whole subject of genetic modification of crops for human consumption.

The Agriculture and Fisheries Committee believes that it should suspend its programme of scientific research into PCN resistance by genetic modification. In agreeing to this the States will be taking a decision that will not shut out for ever the possibility of using new techniques to further enhance the Jersey Royal potato but will be showing that the States is sensitive to present consumer opinion and the views of the farmers and marketing agencies at the present moment.

The Committee has concluded that designating and maintaining the Island of Jersey free from the growing of GMOs, while possibly difficult to monitor, is to be supported at this stage but that given further research this situation may need to be revisited.

Background

In February 1991 the States authorised the Agriculture and Fisheries Committee to commission, on contract, Rothamsted Research Station to undertake scientific research into production of Jersey Royal Potatoes that would be resistant to Potato Cyst Nematode. This would be achieved through bio-technology with the long-term objective being to use the Jersey Royal potato's own defence proteins to produce nematode resistance.

At the time some £229,600 of government money was distributed annually in subsidy for nematicides used on the Jersey potato crop (see Table 1). This was considered unsustainable by the Committee of the time, both for environmental considerations and good government .

Table 1

Nematicide imports/subsidy paid

Year	Tons	£
1990	190.1	285,830
1991	143.6	229,600
1992	n/a	318,565
1993	36.3	322,395
1994	76.1	184,882
1995	92.8	172,800
1996	78.3	151,130
1997	66.9	85,750
1998	74.8	87,874

In 1993/4 the project was independently reviewed by Dr Denis Pigott who was an eminent biotechnologist in the medical field having worked for Imperial Cancer Research. The conclusion of this audit was to continue the valuable work to achieve the objective.

IACR-Rothamsted, as it is now known, is a world renowned Research Station with many research projects aimed at an integrated approach to the study of crop plants.

The present phase of research is due to be concluded in 1999 with the production of the original objective, at a cost over eight years of £660,582. During that time, over £1.8 million has been spent on States subsidy of nematicides.

Progress and current status

The Jersey Royal has been transformed with constructs containing two different forms of its own defence protein (a cystatin

monomer and dimer). This protein is already present in the Jersey Royal, and is being eaten as part of the genetic material of the tuber. It is only “switched on” in the tuber, therefore, the only manipulation that has occurred has been to “switch on the gene” in the roots of the plant, where it has the effect of inhibiting the digestive enzymes needed by the nematode. In addition, a further protease inhibitor gene has been cloned from Jersey Royal (Jersey Royal non cystatin protease inhibitor JRNCPi) and the literature suggests that it may have a wider range of activity. At present there could be a great deal of scope for further work, both to improve nematode resistance and make refinements to the current genetic modification to improve the acceptability of genetically modified Jersey Royals in the market place. Also the long development stage of measuring stability and heritability of resistance during a bulking-up process could be tested. During that period, the longer-term investigations into environmental and health implications could be determined to everyone’s satisfaction before any submission would be made to the Advisory Committee of Novel Food and Processes.

In October 1996 the Committee also commissioned a PhD project with the University of Luton and AFRC-Rothamsted to investigate fungal antagonists which could reduce the nematode population. It has transpired that the main contender is already present in Jersey soil, therefore the work should conclude by recommending procedures, possibly by application of seaweed, to enhance the natural population of fungi in the soil. See Appendix 1 for other areas of Integrated Pest Management adopted in the production of Jersey Royal Potatoes.

Alternatives and implications

The following section specifically answers the issues raised by Deputy Crowcroft in the proposition P.33/99 lodged on 2nd March 1999.

Throughout Europe there is a general desire to decrease the amount of nematicides applied to the soil. In the Netherlands, legislation has been passed to reduce the use of these products by 50 per cent by the year 2000. Most of the nematicides applied in the Netherlands are for the control of potato cyst nematode. On the United Kingdom mainland, the nematode causes approximately £60 million worth of damage per annum and farmers apply £5 - £9 million worth of nematicides. About 50 per cent or more of potato land in the United Kingdom is infested and many farmers have to apply a fumigant nematicide in the autumn and a granular nematicide in the spring to manage these pests.

It is believed that genetically modified approaches to nematode control provide sustainable alternatives to the use of nematicides and they have particular relevance to the work in Jersey in that they should enable the characteristics of the Jersey Royal potato to be retained in a new line that expresses nematode resistance. The work being done at IACR-Rothamsted involves a novel approach in which defence genes already expressed within Jersey Royal tubers have been engineered to be expressed in the roots where the nematodes feed. This research is still at an early stage and will require ten years’ development before it could be applied commercially.

It is important to separate food safety issues from environmental risks. In terms of food safety there should be no risk as the gene is already present in the tuber which has been eaten for many years. It is not possible to predict the environmental impacts of expressing such a gene within roots but it is considered to be minimal. Obviously, any material would require testing to determine whether there are effects on other nematodes in soil or the general rhizosphere microflora. The promoters that would be used to express this gene will be root specific and would not be expressed in the foliage. Gene flow from GM Jersey Royals to other potato varieties or non-GM Jersey Royals is not a concern as (a) potatoes are not propagated through true seed, and (b) the Jersey Royal potato does not flower before harvest, other than occasionally in “seed” crops.

Concerns over the mixing of GM and non-GM crops could be assuaged by the use of a very simple, and already developed, diagnostic test which would enable GM tubers to be readily identified. Hence, the spread and use of these crops could be independently monitored.

See Appendix 2 for further details prepared by IACR - Rothamsted.

As has been observed in the United States where GM potatoes are widely grown, initial concerns amongst consumers over the use of GM crops have disappeared and there is wide acceptance. It is too early to predict whether similar trends will occur in Europe, but it does seem likely.

Other methods of control discussed by Deputy Crowcroft have severe limitations. Companion planting, which is the planting of other species which might deter a pest species, has been tried in the Netherlands and in the United Kingdom and has generally given poor control. Such measures are difficult for the grower to manage and often compete with the crop causing yield reduction. Work on such crops in the United Kingdom was abandoned when MAFF support was withdrawn. Trap cropping, which is a crop being pulled out prior to a harvestable yield being produced, may give significant levels of control but requires very careful timing, may not be economic and may not fit readily into crop rotations, especially in intensive potato cropping systems such as those used in Jersey.

The use of soil amendments is less effective and requires large amounts of organic matter, which may be appropriate for small-scale growers with ready access to material, but may not be suitable for all growers on the Island. Biological control has shown considerable promise in intensively cropped production systems and has much relevance to the situation in Jersey. Production and delivery systems need development and, as yet, no consistent control has been achieved under field conditions, but new isolates of fungi collected from Jersey look more promising than those originally tested against PCN at Rothamsted. There is still much research and development that needs doing, including risk analysis of inundative releases of these fungal agents. Current experience suggests that biological control requires integration with other control measures.

Public concerns

Perception	Fact
1. Transgenic plants have involved introducing a gene from unrelated species which is unnatural.	The Jersey Royal genetically modified WILL NOT be transgenic. ONLY Jersey Royal's own genes have been modified.
2. Unknown health implications.	(a) Genetically modified and even transgenic potatoes have been consumed in the USA for some years with no evidence of adverse impact on human health problems. (b) With the five year moratorium on release of GM fresh produce in the United Kingdom, time would be given to clinical trials.

<p>3. Environmental risk to biodiversity and general contamination.</p>	<p>Professor Phil Dale of John Innes Research Institute, Norwich (also a member of ACRE) (the Advisory Committee for Releases to the Environment) is quoted as saying “A number of studies in different countries had shown that cultivated potatoes were unable to hybridise with the two main solanaceous weed species <i>Solanum dulcamara</i> and <i>Solanum nigrum</i>.”</p> <p>Therefore gene transfer by pollen is not considered to be an important risk. Professor Dale has measured pollen movement from one potato crop to another and claims it rarely exceeds 20 metres.</p> <p>In addition, Jersey Royal potatoes are propagated vegetatively, i.e. not grown from true seed. Over the 150-year history of production, the genetic content of the clone “Jersey Royal” has been maintained and is identical to the original introduction. This has been confirmed several times through genetic fingerprinting.</p>
<p>4. The bias of the Government’s Advisory Committees to big business and food production.</p>	<p>All the present regulations are continually reviewed, and decisions are considered by <u>several</u> committees.</p> <ul style="list-style-type: none"> ◆ Advisory Committee on Genetic Modification - an advisory committee of the Health and Safety Commission. ◆ Advisory Committee for Releases to the Environment. ◆ Advisory Committee for Novel Foods and Processes - (present membership illustrated at Appendix 3.) The membership related to industry or business can be seen to be less than 20 per cent. <p>The outgoing Chairman of ACRE was quoted as saying that he “was constantly surprised that he had not been subject to special pleading by industry, and lobbying by them has been minute in both quantity and passion compared with that from pressure groups”.</p>
<p>5. Continued work could create adverse publicity and thus affect the popularity and profitability of the Jersey Royal.</p>	<p>The Committee has made it clear that there is no possible chance of the genetically modified material being released for several years and then only</p>

after undergoing rigorous independent assessments and acceptance by United Kingdom Advisory Committees.

Nevertheless the perception that Jersey Royal potatoes are being modified could be used to advantage by competitors.

The Committee has consulted with the growing industry and the Marketing Groups, and it is the consensus of opinion that the work should be suspended. However the majority of growers continue to be supportive of the aims of the project but believe that the incredible level of media coverage and consumer concern presents a real danger to their livelihood if the project continues at this time.

The release of any genetically modified Jersey Royal potatoes or indeed any other fresh produce is many years away, and then only after further extensive field and clinical trials. Nevertheless, the current supermarket policy of withdrawing all genetically modified products (currently only processed foods) means that any association with GM techniques could result in the loss of valuable sales for the Island.

Committee appraisal of work in progress

The Committee visited IACR - Rothamsted in June of this year to discuss with those most closely associated with the work their views and to give the Committee members themselves a chance to question the safety and assurance procedures that are in place.

The Committee heard a presentation by Professor Brian Kerry explaining the high costs of treatment and toxic nature of nematicides in the United Kingdom and world context. They were then shown around the laboratory to see that modified Jersey Royal was still at the laboratory bench and glasshouse stage of production. They also saw the work that was being carried out on environmental risk assessments on other crops, which would be extended to potatoes.

The Committee was satisfied with the integrity and professionalism of Rothamsted and accepted that given the current rate of progress it would be several years before the crop became a commercial reality.

Recommendations

- (a) *To take all possible steps to designate and maintain the Island of Jersey as free from the growing of GMOs (genetically modified organisms)*

The Committee believes that section (a) of the proposition has much to commend it but in **supporting** it would note that monitoring the freedom from GMOs (Genetically Modified Organisms) would be difficult to control, given the increasing number of species now released throughout the world. However given that circumstances will change, the Committee believe that members may in time seek to revisit the issue to change this proposal.

- (b) *To suspend the programme of scientific research into PCN (potato cyst nematode, or eelworm) - resistant strains of the Jersey Royal Potato which was authorised by the States on 9th March 1991.*

The Committee **support** Part (b) of the Proposition as worded, but also wish that members be given the opportunity to revisit this issue in future, should future United Kingdom research show that genetically modified potatoes become acceptable to consumers in time.

**INTEGRATED PEST MANAGEMENT STRATEGY
FOR CONTROL OF POTATO CYST NEMATODE**

Standard control measures employed in potato production include -

1. Growing only a variety that is bred to be resistant to the pest.
2. Crop rotation, at least five to seven years between potato crops.
3. Detailed soil sampling for potato cyst nematode to establish the level of infestation in the soil.
4. Control of Volunteer's i.e. re-growth from tubers left in the field after harvest.
5. Early lifting of the crop.
6. Establishing and enhancing the fungal soil microflora that are antagonistic and pathogenic to potato cyst nematode.
7. Use of nematicides at threshold levels.
8. Use of organic fertilisers e.g. seaweed.

Work at the Department of Agriculture addresses several of these areas

1. Due to market forces and the unique brand only 'Jersey Royal' is grown, therefore traditional breeding to develop resistance to potato cyst nematode could not produce a genetically identical variety with similar characteristics, such as taste.
2. Due to the intensity of production and value of land, growers are unable to practice rotation, however, the point made at 5. counteracts this in some way. A realistically effective rotation would result in only 20 per cent of the present acreage being grown, i.e. a reduction to approximately 3,500 vergées which would not return an economic income to the present farming community.
3. Soil sampling since 1987 has become more detailed, and laboratory analytical procedures more specific, leading to very accurate data collected from every field annually.
4. Major efforts are made to ensure growers do not allow volunteer potatoes to develop by encouraging their removal before the nematode population increases. This involves provision of a specific herbicide applicator by the Department of Agriculture and Fisheries, subsidy for the herbicide involved and field inspection by the Department of Agriculture and Fisheries.
5. When the Jersey Royal crop is harvested between nine and 13 weeks after planting it is in effect acting as a "trap crop", in that a short-term crop does not permit the nematode to complete its life cycle.
6. The University of Luton in conjunction with Rothamsted Research Station is due to complete a three-year study in October 1999, on the effect of fungi isolated from Jersey soils. Future development of this work will aim to identify the use of organic soil amendments which could enhance the naturally occurring population of these fungi.
7. As there are still some 74.8 tonnes (1998 data) of nematicides used on the acreage of maincrop, early potatoes, and outdoor tomatoes further work is continuing to analyse fields in an even more critical way. Grid-mapping of each field could ensure that ONLY the specific area in a field where the nematode occurs should be treated with the chemical. This procedure would however, have a considerable resource implication.
8. Research in recent years has shown that use of beach seaweed, compared to products derived from seaweed or shell, does in fact have an effect in decreasing the population of nematodes.

ADDITIONAL COMMENTS PROVIDED BY IACR-ROTHAMSTED

Implications of the removal of support for the Rothamsted-Jersey Project

The possible suspension of the Rothamsted-Jersey project has several implications -

- As has already been demonstrated the possible suspension of the research programme has attracted media coverage and should a suspension be upheld the environmentalist lobby, as an example of their power would exploit it.
- Competing growers in the United Kingdom, by simply exploiting the current public concern, will have removed, at a stroke, the lead in this technology currently earned by the States of Jersey's investment (£600K).
- Research on engineering resistance to potato cyst nematodes will continue at several research centres in the United Kingdom, including Rothamsted, and elsewhere in Europe. The genetic technology produced by this research will be available to all potato growers at a price, but will not be carefully tailored to the requirements of Jersey Royal producers and consumers.
- Potato production on the island will remain dependent on the use of toxic nematicides for the foreseeable future at a time when there is increasing pressure to reduce their use. Supermarkets already demand that nematicide use is minimised and some European countries such as Belgium have banned their use. Further public and legislative pressure to reduce their use would force production of potatoes onto uninfested land (35 per cent of the current United Kingdom potato-producing area), impose longer crop rotations, and increase dependence on production abroad. All of which would have a significant effect on potato production in Jersey. The GM Jersey Royal would provide the island's potato growers with a safe alternative to the use of nematicides.
- Expertise in the manipulation of Jersey Royal potatoes built up at Rothamsted over the programme will be lost and difficult to replace quickly.

Rothamsted scientists have much experience in testing for effects of GM crops on non-target organisms and on gene spread by pollen. Recent research in the Entomology and Nematology Department, (*Nature* 400, pp. 825-826) acclaimed by English Nature and Friends of the Earth for its quality, showed distinct advantages in the use of oilseed rape expressing insect resistant genes and no detrimental effects on non-target organisms.

Genes and Jersey Royal

The flavour, shape and other distinctive characteristics of Jersey royal are dictated by its genes, which have been selected over generations to create a clearly identifiable and separate variety of potato.

Today, molecular methods are able to distinguish the Jersey Royal from other potatoes. Modern biotechnology methods can also be used to alter the expression of genes or insert additional ones that provide new characteristics such as pest resistance.

What are Genes?

Genes are segments of DNA (deoxyribonucleic acid) that code for proteins. A plant requires many thousands of different proteins to grow and reproduce. The regulation of these genes is complex and, at present, genetic modification only involves the manipulation of one or two of these many genes within a plant. In contrast, traditional plant breeding involves a major re-assortment of genes that produces a hybrid with new characteristics that differ from either parent.

Although DNA is a large and complex molecule it is made up of only four different nucleotide bases. It is the number and combination of these bases that make up a gene and form the recipe for the production of specific proteins.

Genes are switched on by specific sequences of DNA called promoters that may be tissue specific i.e. only found in roots or are inducible i.e. only switched on in response to a stimulus, such as the presence of a pest.

Genetic modification and the Rothamsted-Jersey Project

Genetic modification using molecular techniques aims to insert, remove or alter the activity of genes in order to improve the characteristics of an organism in a targeted manner that is not possible through traditional breeding methods

The successful transfer of a single gene is difficult to detect and markers such as an antibiotic resistance gene attached to the

gene of interest is required to identify modified cells. These markers have caused food safety concerns that have not been substantiated. The markers can be removed at a later date.

The Rothamsted-Jersey Project involves the expression of plant defence genes in Jersey Royal potato roots to provide resistance to the potato cyst nematode.

The technology developed has been used to identify defence genes that are naturally active in Jersey Royal tubers. These genes are not normally expressed in roots where they would affect nematode development.

Research done on the project has modified the expression of these genes so that they produce the same defence proteins but in the roots (where they can provide a defence against nematode attack) as well as in the tubers. Such modification has provided practically exploitable levels of resistance to potato cyst nematodes and represents a significant scientific advance of much commercial value.

Hence, there would be no foreign genes in the proposed modified Jersey Royal, only the expression of genes in the roots would be altered; the nematode itself modifies gene expression in roots, as part of its infection process.

Future work

Present progress relies on the use of a non-Jersey Royal promoter and the use of a marker gene. As planned, it was proposed to use only a Jersey Royal gene and promoter in the final nematode resistant lines produced.

Hence future work would -

- Identify a suitable promoter from Jersey Royal and remove the antibiotic resistance marker in future constructs.
- Assess the stability of the genetically modified lines during bulking up of the numbers of tubers to ensure consistent levels of resistance against a range of potato cyst nematode populations within Jersey.
- Assess the performance and quality characteristics of the genetically modified lines with standard Jersey Royal.

All such work could be done at IACR-Rothamsted over a five-year period with existing levels of staff inputs.

GM safety issues

It is very important not to generalise when assessing the risks associated with the genetic modification of crops. The Rothamsted-Jersey Project involves the modification of the expression of genes already present in the standard Jersey Royal, ultimately the marker gene will be removed and the inserted construct (defence gene and promoter) will be from the potato. Hence -

- GM Jersey Royal would alter only the expression of a protein already present in the tuber and leaves of the standard cultivar and is unlikely to present any health risk. It would be routinely screened for any harmful effects as part of the Government's Safety Regulations. Such procedures are still not required for non-GM new cultivars although the risks are similar.
- Potatoes are usually harvested before they flower and present no risk of pollen transfer. Volunteers that are allowed to flower may spread pollen to other potato cultivars and, in theory, could result in gene transfer. However, as potato crops develop from tubers and not true seed this is also not a risk. In reality, pollen spread between non-GM potatoes has not affected the integrity of specific cultivars.
- Potatoes do not cross hybridise with related weeds such as nightshades.

In summary, the risks of GM Jersey Royals to the environment and the consumer are similar to those of introducing a new non-GM potato variety. These are slight especially when compared to those associated with the current nematicides that are used on the crop and could be replaced if a resistant Jersey Royal were available.