

# Effective risk assessment of GM field peas

*The findings of a risk assessment study emphasise the effectiveness of case-by-case evaluation of GM plants and the important role science can play in decision-making around the introduction of GM crops.*

## The importance of peas

Field peas are an important rotation crop for Australian farmers. Worth \$100 million a year, they add nitrogen to the soil and reduce root disease among following crops.

But field peas are susceptible to the pea weevil *Bruchus pisorum*, which lays its eggs on the pea pod. When the eggs hatch, the larvae eat their way through the pod and into the seed, where they develop into adults, leaving a large hole when they emerge from the pea.

Weevils can reduce yields by up to 30 per cent and any sign of weevil damage will cause the peas to be downgraded in quality and reduced in value. Weevil damage also reduces the viability of seeds for the following season. Crops must be hand-checked for infestation every three to four days from the start of flowering if pesticides are to be applied in time to prevent infestation.

## Alpha-amylase inhibitor GM peas

CSIRO developed genetically modified field peas using a gene from beans.

Unlike peas, beans are not attacked by pea weevils. Beans contain a protein that inhibits the activity of alpha-amylase, an enzyme that helps in digestion of starch. This protein inhibitor, called alpha-amylase inhibitor, causes the weevils feeding on beans to starve before they cause any damage.

CSIRO scientists and their collaborators identified the gene that produces the protective protein. Using gene technology they then introduced the gene into the pea. Field trials showed the genetically modified peas were 99.5 per cent resistant to pea weevils.



*The CSIRO-developed GM field peas (right) provided 99.5 per cent protection against the pea weevil *Bruchus pisorum*.*

## Risk assessment

CSIRO's GM field peas underwent a number of tests during development:

1. Laboratory and glasshouse tests
2. Performance studies in the field
3. Feeding trials
4. Immune response tests

Results of trials 1 – 4 are published in scientific literature.

## Feeding trials

The bean alpha-amylase inhibitor protein has been studied extensively over many years and has shown no health risk to humans or animals. However as part of its risk assessment, CSIRO worked with other research groups to conduct feeding trials in chickens and pigs.

In two feeding trials with the University of Sydney chickens were fed GM and non-GM field peas incorporated into a maize-soybean diet. In the first trial birds were fed the diet from 3 – 17 days post hatching. In the second trial the birds were fed the diet for 40 days.

In another trial with the Victorian Department of Primary Industries, pigs were fed wheat mixed with either non-GM or GM field peas for 15 days.

Results of each study showed that while protein digestion was the same in pigs and chickens fed GM or non-GM field peas, starch digestion was reduced in animals eating the GM field peas. This indicated that the alpha-amylase inhibitor protein also affected digestion of starch in these animals and may not be suitable for stock feed.

### **Immune response study**

CSIRO asked the John Curtin School of Medical Research in Canberra (JCSMR) to help examine whether the pea form of the alpha-amylase inhibitor protein caused an immune reaction in mice.

Mice were fed either beans, non-GM peas or alpha-amylase inhibitor GM peas twice a week for four weeks. In a separate experiment, the reaction to the pea alpha-amylase inhibitor protein was compared to bean alpha-amylase inhibitor protein when administered to the mice lungs.

Mice fed beans did not show evidence of an immune reaction. Similarly, mice fed non-GM peas did not demonstrate any immune reaction.

Mice exposed to alpha-amylase inhibitor GM-peas showed evidence of an immune response after two weeks, with the response increasing at four weeks. The reaction in mice was evident by inflammation in the lungs and increased serum antibody levels. The research also showed that after eating the GM peas, there was evidence that the pea alpha-amylase inhibitor protein primed the mice to react to other food antigens.

### **Why a response to alpha-amylase inhibitor GM peas?**

To understand why the mice reacted to the GM pea alpha-amylase inhibitor, the CSIRO team analysed and compared the molecular structure of the bean and pea alpha-amylase inhibitor proteins.

This revealed small mass differences in the two proteins, most likely to be caused by different protein processing

steps in the two types of legume, including one step called glycosylation.

These processing steps play an important role in making certain proteins, and can lead to variation in a protein's structure. This research shows however, that these variations can have other effects supporting the need for case-by-case assessment of GM crops.

### **Other assessment**

Six performance trials were conducted under field conditions between 1996 and 2001. Results showed the alpha-amylase inhibitor GM peas provided 99.5 per cent protection against the pea weevil with yields comparable to non-GM field peas.

Peas are self pollinating and it is unlikely gene flow would occur between GM and non-GM peas. However CSIRO conducted gene flow studies to test this assumption. The results of the work showed that gene flow did not occur between GM and non-GM field peas.

CSIRO also examined scientific literature to determine what wildlife and in particular birds relied on field peas in their diet. It found little evidence of wildlife eating field peas and provided information for consideration by the former Genetic Manipulation Advisory Committee now the Office of the Gene Technology Regulator (OGTR).

### **The technology**

The technology developed by CSIRO to genetically modify field peas with novel genes is a gene transfer system for peas. The system is now available for use in other research including exploring the potential to develop protection against agronomically important diseases of pea.

### **Outcomes**

Given the findings of this research, CSIRO made the decision to discontinue developing the alpha-amylase inhibitor GM peas. CSIRO is currently investigating the changes in the molecular structure of the alpha-amylase inhibitor GM pea protein that resulted in the immune response in mice.

## References

1. Transgenic Expression of Bean  $\alpha$ -Amylase Inhibitor in Peas Results in Altered Structure and Immunogenicity  
*Vanessa E. Prescott, Peter M. Campbell, Andrew Moore, Joerg Mattes, Marc E. Rothenberg, Paul S. Foster, T. J. V. Higgins, and Simon P. Hogan*  
JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY  
Volume 53, Issue 23 (November 16, 2005) pages 9023 - 9030
2. Starch but not protein digestibility is altered in pigs fed transgenic peas containing  $\alpha$ -amylase inhibitor  
*Cherie L. Collins, Paul J. Eason, Frank R. Dunshea, Thomas J.V. Higgins, and Ray H King*  
JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE  
Published online 12 June 2006  
<http://www3.interscience.wiley.com/cgi-bin/fulltext/112652596/PDFSTART>  
(Available to journal subscribers only. To subscribe contact [cs-journals@wiley.co.uk](mailto:cs-journals@wiley.co.uk))
3. Biological response of broiler chickens fed peas (*Pisum sativum* L.) expressing the bean (*Phaseolus vulgaris* L.)  $\alpha$ -amylase inhibitor transgene  
*Xiuhua Li, Thomas J.V Higgins, and Wayne L. Bryden*  
JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE  
Published online 29 June 2006  
<http://www3.interscience.wiley.com/cgi-bin/fulltext/112679657/PDFSTART>  
(Available to journal subscribers only. To subscribe contact [cs-journals@wiley.co.uk](mailto:cs-journals@wiley.co.uk))

### For further information contact:

CSIRO Enquiries  
Bag 10 Clayton South VIC 3169

Phone: 1300 363 400 (National local call)  
+61 3 95452176 (International phone)

Fax: +61 3 9545 2175

Email: [enquiries@csiro.au](mailto:enquiries@csiro.au)

### Disclaimer

CSIRO gives no warranty and makes no representation that the information contained in this document is suitable for any purpose or is free from error. CSIRO and its officers, employees and agents accept no responsibility for any person acting or relying upon the information contained in this document, and disclaim all liability for any loss, damage, cost or expense incurred by reason of any person using or relying on the information contained in this document or by reason of any error, omission, defect, or mis-statement contained therein.