

TRANSGENIC CANOLA

A. Green and P. Salisbury

SUMMARY

- Transgenic (genetically modified) canola types being developed in Australia include both those with modified crop production traits (e.g. herbicide tolerance) and those with modified product quality traits (e.g. improved oil quality).
- There is significant potential for transgenic canola in Australia. Currently there are no commercial transgenic canola crops grown in Australia, with the first transgenic varieties expected in 2001-2.
- The Genetic Manipulation Advisory Committee (GMAC) oversees gene technology research in Australia. GMAC has set out guidelines and advice on how genetically modified organisms can be handled. GMAC is to be replaced by an Office of Gene Technology Regulation (OGTR) which is expected to have new statutory powers to give approval for commercial release.
- The Australian and New Zealand Food Authority (ANZFA) has responsibility for assessing food safety of products from transgenic plants and approving commercial use.
- The National Registration Authority for Agricultural and Veterinary Chemicals (NRA) is responsible for regulating herbicide and pesticide use. This includes novel pesticides such as *Bt* genes in transgenic crops, and the extension of label permits to allow herbicide use on new herbicide-resistant crops.
- An Institutional Biosafety Committee (IBC) must be established for each transgenic type. The IBC ensures that GMAC guidelines and advice are followed.

INTRODUCTION

Canola is at the forefront of the application of gene technology in agriculture worldwide. Many genetic improvements in canola in the foreseeable future will result from the use of molecular genetic techniques to introduce new genes, modify existing ones or provide more efficient means of identifying specific combination of genes. There is a huge potential for transgenic canola in Australia, but as yet no commercial transgenic canola crops are grown. This chapter examines the current regulatory bodies and guidelines for trialing transgenic canola, the transgenics being researched and field tested in Australia, and future issues.

REGULATORY SYSTEM

The Genetic Manipulation Advisory Committee (GMAC) currently oversees gene technology research and development in Australia. GMAC is a non-statutory body established by the Commonwealth Government in 1987 and its membership includes academics, researchers with expertise in gene technology and representatives of the wider non-scientific community. GMAC is to be replaced by an Office of Gene Technology Regulation (OGTR), which is expected to have new statutory powers to give approval for commercial release.

Each institution working with new gene technology products must establish an Institutional Biosafety Committee (IBC) that oversees all such work within the institution and ensures that researchers comply with GMAC advice and guidelines. All proposals to work with genetically modified organisms (GMOs) are first considered by the IBC, which then forwards the proposals and recommendations to GMAC.

A number of regulatory agencies are involved in approval for release and commercial use of GMO crops and their products. The National Registration Authority for Agricultural and Veterinary Chemicals (NRA) regulates chemical products for agricultural use. Novel pesticides such as *Bt* genes fall under their regulatory control, along with the extension of herbicide labels to allow their use on new herbicide resistant crops. The Australian and New Zealand Food Authority (ANZFA) is involved in the safety and identification of food produced through gene technology, plus issues of labelling of foods derived from GMOs. The Australian Quarantine and Inspection Service (AQIS) regulates the importation of GMOs into Australia.

Planned and General Release requirements

Before any GMO material is released into the field, an application for planned release must be submitted to GMAC. This application addresses all key issues concerning the release, including details of:

- the species to be released, the origin of inserted DNA and the method of DNA transfer
- the locations of all trials
- the natural habitat and distribution of the parent organism
- ecological effects of the release
- environmental safety of the GMO
- capability of the GMO to disperse from the release area
- likelihood of the GMO remaining in the environment after release
- monitoring the survival of the GMO
- likelihood of the inserted trait being transferred to other organisms

The environmental safety of any new product must be demonstrated to GMAC before field release is approved. Issues of critical importance to be addressed in canola include the likelihood of the GMOs, especially herbicide tolerant GMOs, becoming more weedy in their own right, the likelihood of the herbicide tolerance trait being transferred to related weedy species, and the development of multiple herbicide tolerance.

Guidelines have been developed for assessment of proposed General Releases, including industry consultation on potential GMO crop management issues. An overall industry strategy for the safe and effective use of herbicide tolerant canola is being developed as a pre-requisite to general release of these crops.

Guidelines for trialing transgenic canola in Australia

The guidelines for trialing canola in Australia in 1998 were:

- 400 metre isolation from any other canola
- trial site and a 50 metre radius surrounding the trial to be kept free of *Brassica* weeds
- no canola to be sown on the site for the 2 years prior and 3 years after the transgenic canola trial
- removal of volunteer canola plants for 3 years after the transgenic trial
- a 15m non-transgenic canola pollen-trap buffer is to be sown around the trial and destroyed prior to seed set

TRANSGENIC CANOLA TYPES BEING TESTED IN AUSTRALIA

There are currently no commercial transgenic canola crops grown in Australia, but there are a number of transgenic types being field tested under planned release guidelines as shown in Table 4. Details of all Planned Release and General Release Proposals are available on the GMAC web page (www.health.gov.au/tga/gmac/gazette.htm).

Table 4. Summary of release proposals received by GMAC for the planned release of genetically-modified canola in Australia.

Trait	Institution	Planned release or general release proposal	
Hybrid systems	AgrEvo	PR-63	Field evaluation of genetically modified canola (<i>Brassica napus</i>) with a new hybridization system
		PR-85	Small and large scale seed increase of genetically modified canola (<i>Brassica rapa</i>) with a new hybridization system
Basta resistance	AgrEvo	PR-62	Development of glufosinate ammonium tolerant canola cultivars
		PR-90	Herbicide tolerant hybrid <i>Brassica juncea</i>
Fungal resistance	AgrEvo	PR-79, 93, 110 & 119	Development of fungal disease resistant canola
Photoperiod insensitivity	AgrEvo	PR-111	Development of photoperiod insensitive canola
Anti-nutritional factors	AgrEvo	PR-120	Development of methods to reduce anti-nutritional factors
Modified plant architecture	AgrEvo	PR-121	Development of canola cultivars with modified plant architecture
Reduce yield loss	AgrEvo	PR-122	Development of canola cultivars with reduced yield loss
Glyphosate resistance	Monsanto	PR-77	Planned release of transgenic canola expressing tolerance to the herbicide glyphosate (Roundup Ready canola)
Laurate canola	Monsanto	PR-60	Field evaluation of genetically modified canola (<i>Brassica napus</i>) for agronomic performance
Protoplast fusion	Pacific Seeds	PR-14	Field evaluation of canola protoplast fusion breeding lines

TRANSGENIC CANOLA RESEARCH IN AUSTRALIA

In addition to the material already in field trials, there is other basic and applied research work being undertaken that should lead to improved transgenic canola varieties in the future.

Researchers at CSIRO Plant Industry are using gene silencing techniques to develop very-high oleic acid types based on elite Australian *B. napus* breeding lines and advanced double-low *B. juncea* germplasm. Modifications to existing *Brassica* transformation protocols and the use of an intron-interrupted hygromycin-resistance gene as the selectable marker have resulted in improved transformation efficiencies. Silencing of the endogenous oleate desaturase genes have resulted in substantial increases in oleic acid levels, up to 89% in *B. napus* and 73% in *B. juncea*.

Researchers at the Cooperative Research Centre for Tropical Plant Pathology are undertaking studies aimed at the development of transgenic canola plants expressing novel genes for resistance to fungal pathogens such as *Leptosphaeria maculans*, *Sclerotinia sclerotiorum*, *Rhizoctonia solani* and *Alternaria brassicicola*. The genes being tested include those encoding novel antimicrobial peptides derived from Australian native plants and from macadamia in particular. So far, transgenic plants expressing three peptides have been developed and advanced lines expressing one peptide at high levels are under evaluation for improved disease resistance. In other work, a functional genomics approach is being used to identify new genes involved in the signalling and regulation of defence responses in canola. This involves a collaboration with the Carnegie Institution of Washington and is using DNA microarrays to identify genes determining specific defence-signalling pathways. It is hoped that eventually these genes can be tested in transgenic plants.

Researchers at the Plant Biotechnology Centre, Agriculture Victoria have established a robust and efficient transformation protocol for Australian canola varieties and breeding lines. They are undertaking studies aimed at the development of transgenic canola plants, expressing genes encoding antifungal proteins from *Brassicaceae* seeds, for resistance to *L. maculans* and *S. sclerotiorum*. Furthermore, transgenic approaches to enhance yield and to develop a novel inducible male sterility system for hybrid seed production are being tested.

FUTURE ISSUES AND CONCLUSIONS

Transgenic (genetically modified) canola being developed in Australia includes those with modified crop production traits (e.g. herbicide tolerance) and those with modified product quality traits (e.g. improved oil quality). Australian canola breeding and research programs are forming research and commercial linkages with owners of key technologies. In the next ten years, Australian production is expected to come predominantly from GMO varieties. There is a huge potential for transgenic canola in Australia and in the long term, general release will make the testing and selection of new transgenic varieties much easier. The first GMO canola varieties available in Australia will be the Roundup Ready[®] and Liberty Link[®] herbicide resistant types.

FURTHER READING

Green, A and Salisbury, P.A. (1998). Genetically Modified Oilseeds – The impact of gene technology on the Australian oilseeds industry. *Australian Oilseeds Federation Innovations and Technology Committee*. 57pp.