

## Biotech Bulletin 4

# Horticulture Research – Australia and Overseas

Welcome to the fourth edition of Agrifood Awareness Australia Limited's (AFAA) Biotech Bulletin. The Biotech Bulletin, produced on a monthly basis, aims to cover topical gene technology issues.

This edition of the Biotech Bulletin, entitled "Horticulture research – Australia & overseas", focuses on the large amount of horticultural gene technology research currently undertaken in Australia and internationally.

Agrifood Awareness Australia Limited is currently compiling a booklet entitled "Gene Technology in Australia – What's happening in Horticulture?", with support from Horticulture Australia. The booklet aims to provide an overview of gene technology in the horticultural industry in Australia and provides examples of some of the research programs underway.

This newsletter provides a snapshot of the contents of the booklet (due to be launched in the new year) and aims to provide an overview of the considerable amount of gene technology horticultural research undertaken in Australia and overseas.

The primary focus of the research includes:

- in-built protection against major pests, diseases and viruses; and
- quality traits to improve colour, flavour, shelf-life, taste and ripening.

The following highlights examples of gene technology research in horticultural commodities including flowers, fruits and vegetables.

### **FLOWERS**

#### **CARNATIONS**

Carnation varieties with blue-violet/mauve colouring are Australia's only commercially available genetically modified (GM) horticultural product. The carnations have been sold from florists since 1996. The GM carnations (developed by Florigene) are also approved for sale in Japan and North America.

Carnations with a longer vase life are also being developed using gene technology. The aim of the project is to develop carnations that once cut, deteriorate more slowly, thus producing a longer life cut flower.

### **FRUITS**

#### **BANANAS**

In Australia, researchers are using gene technology to identify genes for resistance to:

- Bunchy Top Virus - a devastating disease that causes serious production losses;
- Black Sigatoka disease - an exotic fungal disease that now occurs in most banana growing areas globally and remains a major threat to Australia's banana industry; and
- Panama disease - a serious fungal disease that is generally spread by soil, water or banana plants (the actual fruit does not carry the disease) and will eventually kill the plant.

In Kenya, researchers are using gene technology to improve banana production for small-scale producers. A severe decline in production threatening food security and incomes in banana producing areas caused by soil degradation and infestations by pests and diseases in recent years has led to the use of biotechnology. The aim of the project is to make clean planting supplies of improved banana

varieties available to farmers. There have been very positive results from field trials, with improvements in growth and yield achieved by the new varieties.

In the United States, researchers are claiming to have doubled the shelf-life of bananas. This technology has slowed down the ageing process of the plant cells, delaying blackening and spoilage of bananas. This is an important characteristic for consumers, growers, shippers and retailers of bananas.

## **CITRUS**

A citrus project utilising gene technology was one of the first gene technology horticultural projects in Australia. CSIRO scientists constructed two genes which inhibit seed formation. One gene had the potential to decrease seed numbers by 75 per cent while the other gene made plants destroy all their seeds early in the development stage. Scientists inserted these two genes into the West Indian lime. The lime fruit from the GM tree had significantly less seeds, or smaller, soft seed traces.

Genetically modified citrus trees have been developed in Texas, in the United States, to protect the citrus industry from the brown citrus aphid that has already destroyed millions of citrus trees in Argentina, Brazil, Mexico and Venezuela. The brown citrus aphid, carried by wind and commercial ships, is a highly effective carrier and spreader of the citrus tristeza virus (CTV), a disease that is feared by orange and grapefruit growers globally. Certain citrus-tree varieties are more susceptible to CTV than others. Field trials of around 100 citrus trees modified to resist CTV in different ways are being assessed and trialled in the United States. The field trials of the modified trees are not only assessing the technology success, but also taste and safety of the grapefruits and oranges.

## **GRAPEVINES**

Australia's wine, grape and dried fruits industries are worth around \$1.5 billion a year. CSIRO has developed Australia's first GM grapevines. Field trials of the modified grapevines are currently underway. The researchers are aiming to create grapevines with enhanced flavour, improved colour and increased disease resistance.

Genetically modified grapevine varieties are also being developed in the United States. These high quality grapevines have been modified to overcome specific soil limitations (such as high soil lime content) and are tolerant to the phylloxera (an insect that feeds on both the root and foliage of the vine).

Another project is looking at switching off the gene that causes the sultanas to turn dark brown, to produce golden-coloured sultanas.

## **MANGO AND PAPAYA**

Research is underway to identify the genes involved in the initiation and control of flowering for ripening in mangoes and papaya. This work aims to gain a better understanding of the processes involved in the plants' switch from vegetative growth to the development of flowers.

Research has shown that once fruit is fully ripe, it starts to undergo natural tissue breakdown, which often results in significant losses during transportation and storage. This is particularly true of mango and papaya, which are primarily produced in the tropics. Research is now seeking to control ripening by altering the rate at which the fruit expresses this enzyme. The long term outcome of the research may be modifying papaya and mango growth habits to suit local conditions. For example, in Australia's tropical north where mango varieties such as Kensington Pride do not perform very well.

The most serious papaya virus is the Papaya Ring Spot Virus (PRSV), which is common in Florida, Cuba, Puerto Rico, Trinidad and first seen in Hawaii the late 1950s, transmitted by aphids. The PRSV virus virtually reduced large-scale papaya production during the 1950's in Hawaii, causing the papaya industry to relocate in the early 1960s. Plants affected by this virus display stunted growth, deformed and inedible fruit, and eventually, the plant dies.

Papaya plants with in-built protection against PRSV have been developed. These varieties of papaya have received regulatory approval as a food product for consumers in the United States (in 1997) and Canada (in 2003) and offer benefits of an improved source of vitamin C, reduced costs in papaya production and less spraying required to control viral disease.

## **PINEAPPLES**

Research in Australia and Malaysia is examining the potential for gene technology in pineapples to both delay or synchronise flowering (greatly simplifying harvesting and marketing) and to reduce blackheart, (a discolouration of the tissue of the pineapple plant). In Australia, blackheart occurs in the field in winter-grown crops, causing heavy losses to industries due to downgrading of fruit quality, immature harvest of fruits and reduced winter production.

Another project in Australia is utilising gene technology to prevent ethylene production (a gas that causes the fruit to start ripening), and applying ethylene at the right stage of the plant's development, to deliver synchronised flowering and therefore ripening. Field trials for these two projects are currently underway.

## **STONE FRUIT**

The Plum Pox virus infects stone fruit species including peaches, apricots, nectarines, plums and almonds (most strains do not infect cherries) causing deformed or blemished fruit with spots or rings. Plum Pox virus is transmitted from infected trees either by grafting (joining a bud with a growing plant) or by aphids. The virus causes significant economic losses to the stone fruit industry. Researchers in the United States are developing Plum Pox virus resistant stone fruit, to prevent the virus that causes significant economic loss to the stone fruit industry.

## **STRAWBERRIES**

Weeds cause more loss than insect and disease pests combined to strawberry grower's production in the United States. Using gene technology, researchers have inserted a bacteria gene into strawberries, which allows the fruit to be resistant to the herbicide glyphosate.

Researchers are also working to improve the market life of fresh strawberries to keep the fruit firmer after harvest and adding genes to resist disease.

## **TOMATO**

Tomatoes were one of the first GM products commercially sold. The Flavr Savr™ tomatoes were field tested in the United States from 1988 to 1992 and were approved for commercial sale in 1994. The tomatoes were modified to delay ripening of the fruit by reversing a gene normally found in a tomato. By delaying the ripening, the tomato ripened on the vine for a longer period, in turn, improving its flavour and maintaining its firmness, which was valuable during transportation. Flavr Savr™ tomatoes were expected to provide an alternate or additional choice to consumers and food manufacturers. While the project was a success, an unsuitable variety of tomato was used and as a result, the fresh tomato did not succeed in the marketplace. The tomatoes are no longer commercially available.

Genetically modified tomatoes in the United Kingdom also with delayed ripening properties, were available as canned tomato puree in 1996 and labelled as genetically modified. Initially the GM tomatoes sold competitively on supermarket shelves however increasing public concern resulted in them being removed from sale.

Field trials are currently underway for a new cancer-fighting tomato variety that has been under development for ten years in the United States. The new variety offers more than three-and-a-half times more of the cancer fighting antioxidant lycopene, which is believed to lower the risk of cancer as well as coronary heart disease. It is expected that commercial varieties of the lycopene increased tomatoes will be available in the United States in the next two to four years.

## **VEGETABLES**

### **LETTUCE**

A researcher in Singapore has used gene technology to develop a new type of lettuce that is equipped with resveratrol, the ingredient in red grapes and red wine that is believed to help prevent heart disease and cancer by increasing levels of good cholesterol and lowering the levels of bad cholesterol. Using this type of modification, the research team is hoping to genetically modify other fruits and vegetables, including spinach, tomatoes, cabbage, watermelons and strawberries.

### **POTATOES**

Low browning potatoes were one of the first GM horticultural crops developed in Australia by CSIRO. Mechanical harvesting and transport often damages the potato causing brown or black spots to appear

on the flesh, a condition known as 'blackspot bruising'. Although this does not affect the taste or nutritional value of potatoes, it makes them unappealing to consumers.

CSIRO researchers isolated the enzyme (polyphenol oxidase [PPO]) that is released when potatoes and many other fruits and vegetables are damaged. It is PPO that causes blackspot bruising. The researchers identified the gene and inserted it back into the DNA of the potato, switching off production of PPO, resulting in a non-browning potato. Most plants during field trial evaluation grew normally and had equivalent yields to non-GM plants, but they did not go brown when bruised.

Currently, these potatoes are not commercially available in Australia. This technology is being further developed in the United States and Europe. The aim of the technology is to produce varieties with a lower susceptibility to browning, lowering production losses and processing costs. The low browning technology is also useful in other crops such as bananas, apples, grapes and sugar cane.

In the United States, Japan and Canada a GM potato has been approved for commercial production. Introduced in 1995, the New Leaf® Insect-Protect Potato (produced by Monsanto), was the first commercial crop to be protected against insect pests through gene technology. The potato is resistant to the Colorado potato beetle. Despite commercial approval, the potatoes are not widely grown.

In the United States, researchers have developed potatoes resistant to the fungus, late blight. The fungus can infect and destroy the leaves, stems and tubers of potato, most rapid during conditions of high moisture and moderate temperatures. Researchers have inserted a gene from a species of wild Mexican potato into the commercially available varieties of potato. To date, the GM potato has performed well in field trials.

## **SQUASH**

Diseases, such as mosaic viruses, are a limiting factor to squash production, particularly during summer and autumn. Mosaic viruses include the cucumber mosaic cucumovirus (CMV), zucchini yellow mosaic potyvirus (ZYMV), and watermelon mosaic potyvirus (WMV2). Squash resistant to CMV, ZYMV and WMV2 have been developed. These varieties are commercially available in both the United States and Canada.

## **SWEET POTATO**

A new GM sweet potato is being field tested in Kenya that has built-in resistance to the sweet potato feathery mottle virus (SPFMV), in combination with other viruses. The SPFMV is a devastating virus that can cause up to 80 per cent crop losses in many parts of Africa.

The sweet potato project has been going on since 1997. Because the sweet potato is energy-rich, packed with vitamins and drought resistant, it is a very important staple crop in many developing countries, including Africa.

## **OTHER**

Other horticulture research projects in brief include:

- **Coconuts** - Researchers in the Philippines are looking at fatty acid modification and insect-resistance in coconuts using gene technology.
- **Peanuts** - Scientists in the United States are in the process of studying peanuts to identify and remove the gene producing protein responsible for allergic reactions in susceptible people.
- **Purple pigment in berries and vegetables** - CSIRO Food Science researchers in Australia are using biotechnology to extract anthocyanins, the purple pigment found in berries and vegetables, which have anti-oxidant properties, from a Japanese sweet potato variety. The aim of the research is to utilise the extracted pigment as a healthy replacement for artificial colours currently used in everyday foods. The end food products of the project would not be genetically modified.
- **Other flowers** - Researchers at Peking University have developed a method to control the flowering time of Dendrobium orchids through gene technology. The aim of the research is to allow orchids to flower all year round.

There is a substantial amount of research investigating the potential of gene technology in horticultural products around the world, although few products are commercially available. Future development of these products will depend on research success and market/consumer perceptions.

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We look forward to your feedback on this newsletter.

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