

# Horticulture and GMOs

## Current Status and the Future

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Current Status and Current Traits

Pipeline for Horticultural Crops

Pomegranate? Thinking ahead.

Q & A

Transgenic crop technology (familiar “GMO”) is a precise extension of conventional plant breeding.

“The techniques used pose no more risk (actually less risk) than conventional breeding.” (NAS, AAAS, AMA, EFSA many others)

In 17 years there has not been one case of illness or death related to these products

There are several traits used in only eight commercial crops, two of them horticultural crops

# GM Crops Available Now

## BIOTECH



**8** Common Crops Commercially Available Use Biotech Seeds, reducing crop loss to insect and plant diseases as well as drought and other environmental conditions.

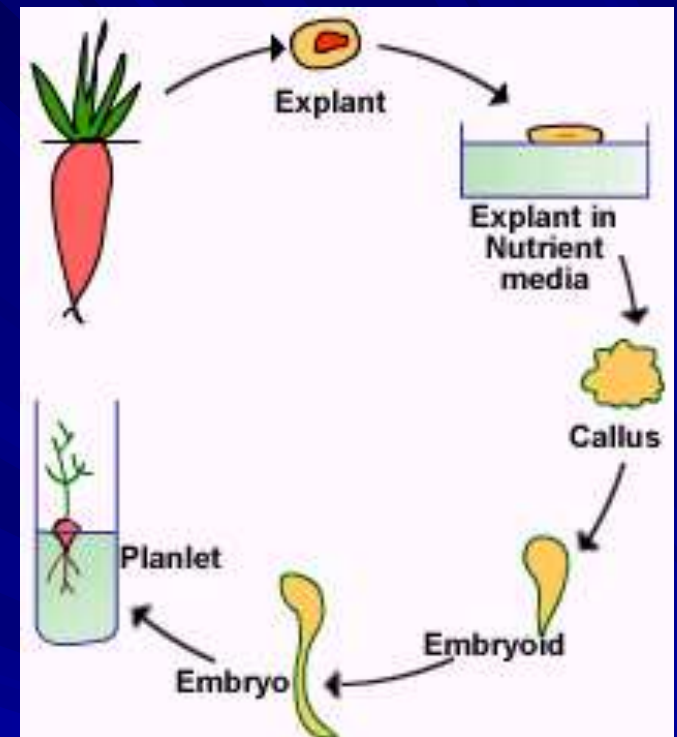
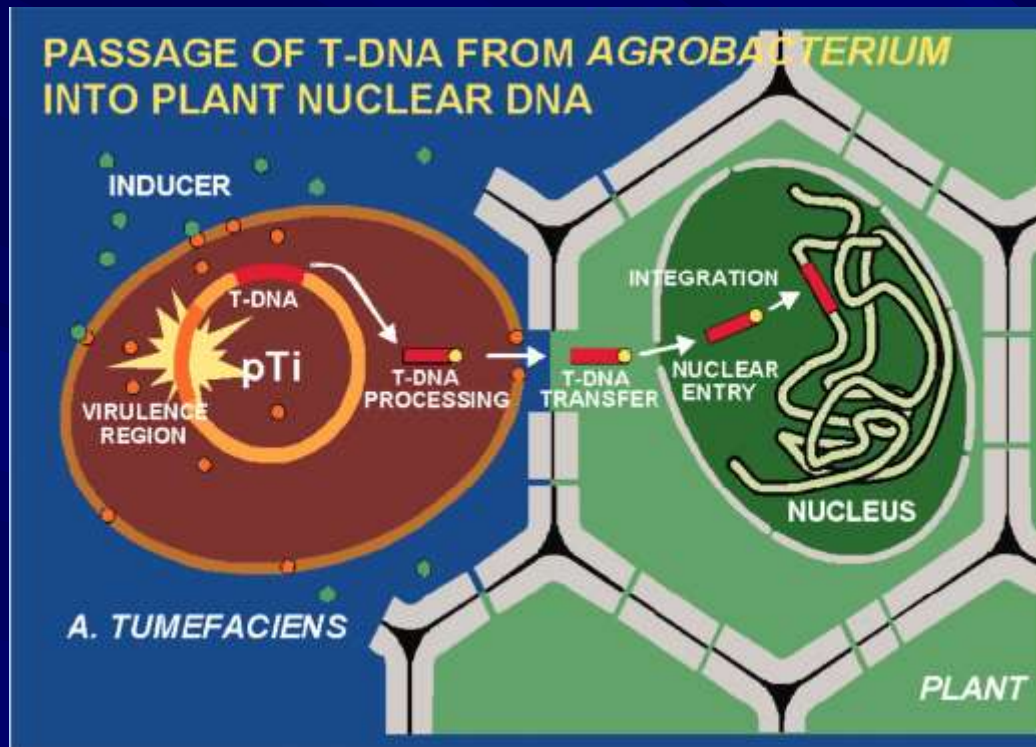
SOURCE: [www.isaaa.org](http://www.isaaa.org)

# How Do We Add a Gene to a Plant?





## Agrobacterium is nature's genetic engineer



Once the gene of interest is in one cell, it can be regenerated into a new plant.

How do the traits work?

Two main traits– Bt and glyphosate resistance

Bt is one of many natural anti-insect proteins

**DiPel<sup>®</sup> PRO DF**

**BIOLOGICAL INSECTICIDE DRY FLOWABLE**

For Organic Production

Active Ingredient:  
*Bacillus thuringiensis*, subsp. *kurstaki*, strain ABTS-351,  
fermentation solids, spores, and insecticidal toxins

Other Ingredients

Total

Potency: 32,000 Cabbage Looper Units (CLU) per mg (14.5 billion CLU per pound)

The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

**KEEP OUT OF REACH OF CHILDREN  
CAUTION**

FIRST AID	
If on skin or clothing	<ul style="list-style-type: none"><li>• Take off contaminated clothing.</li><li>• Rinse skin immediately with plenty of water for 15-20 minutes.</li><li>• Call a poison control center or doctor for treatment advice.</li></ul>
If inhaled	<ul style="list-style-type: none"><li>• Move person to fresh air.</li><li>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.</li><li>• Call a poison control center or doctor for treatment advice.</li></ul>
If in eyes	<ul style="list-style-type: none"><li>• Hold eye open and rinse slowly and gently with water for 15-20 minutes.</li><li>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li><li>• Call a poison control center or doctor for treatment advice.</li></ul>

**HOTLINE NUMBER**

Have the product container or label with you when calling.

**PRECAUTIONARY STATEMENTS**  
**HAZARDS TO HUMANS AND DOMESTIC ANIMALS**  
**CAUTION**

Harmful if inhaled or absorbed through the skin. Causes moderate eye irritation. Avoid breathing dust or spray mist. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Remove contaminated clothing and wash before reuse.

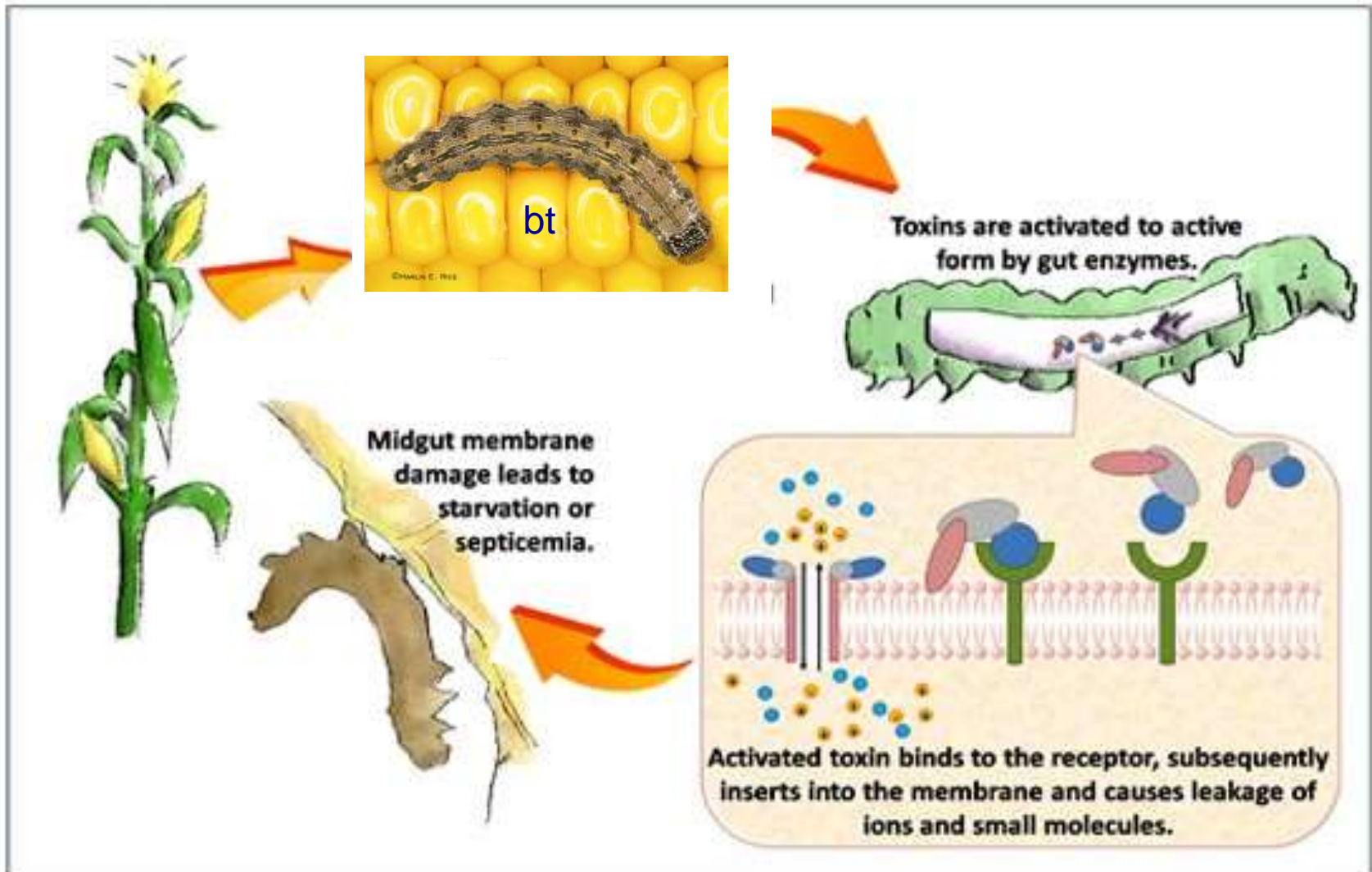
Mixer/loaders and applicators must wear a dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.

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# How Bt Works



## Advantages

Decrease in broad-spectrum insecticide use on corn and cotton

Lower fuel and labor costs for farmers

Solid dividends in the developing world

No effect on beneficials

## Limitations

Need to plant refugia to slow resistance

Pockets of resistance are seen and require use of insecticides

Requires careful scouting

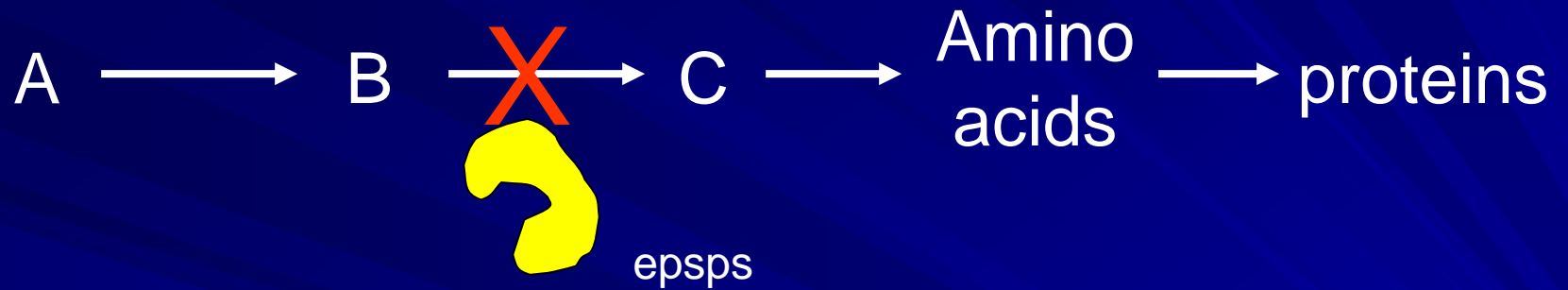
# Glyphosate-Resistant (Roundup Ready) Products



A gene is inserted that allows plants to survive in the presence of the herbicide. Farmers can spray to kill non-transgenic plants.

# How Herbicide Resistance Works

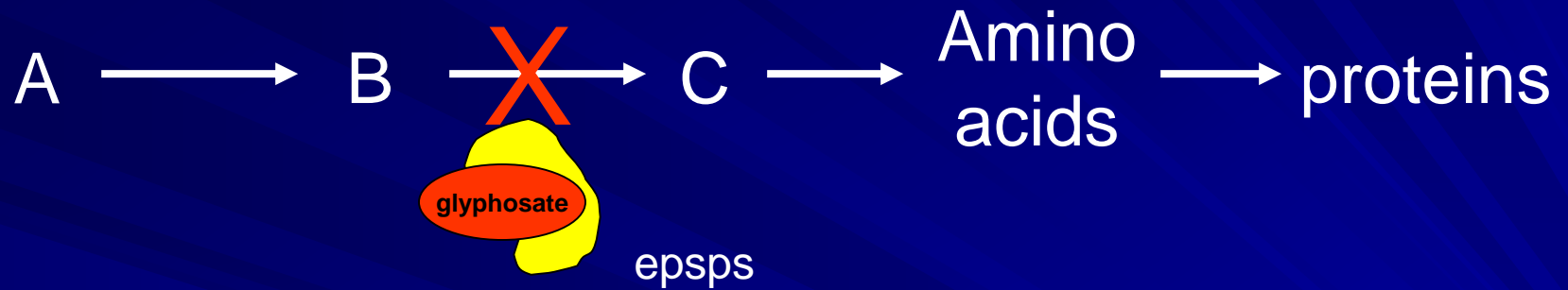
## Plants



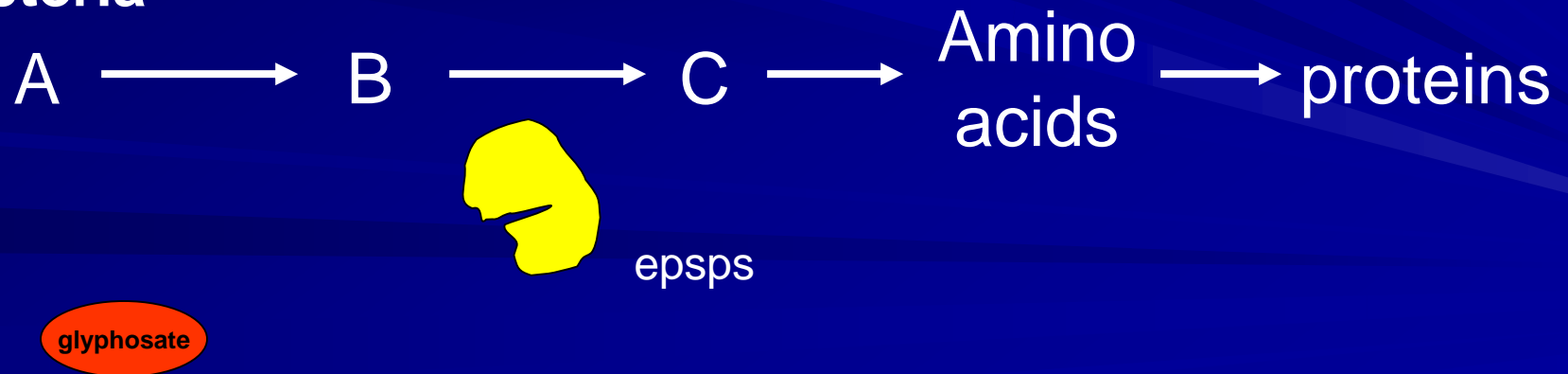
glyphosate

# How Herbicide Resistance Works

## Plants



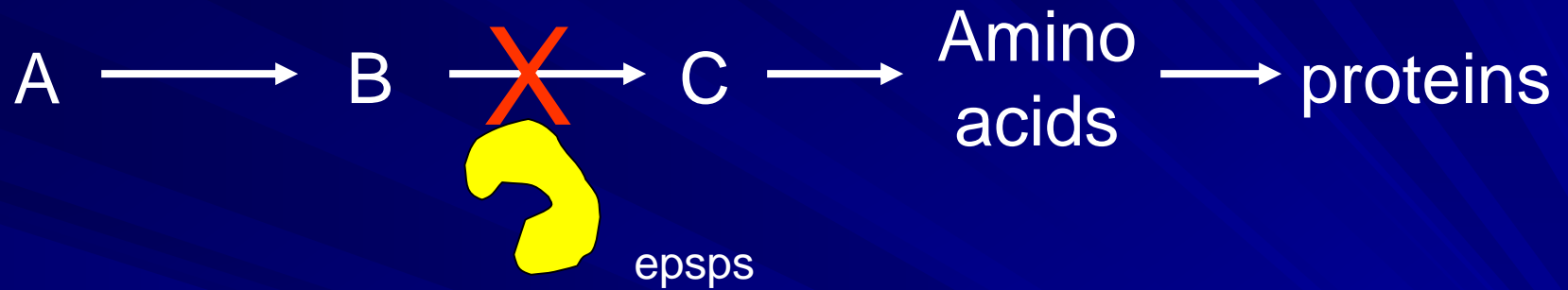
## Bacteria



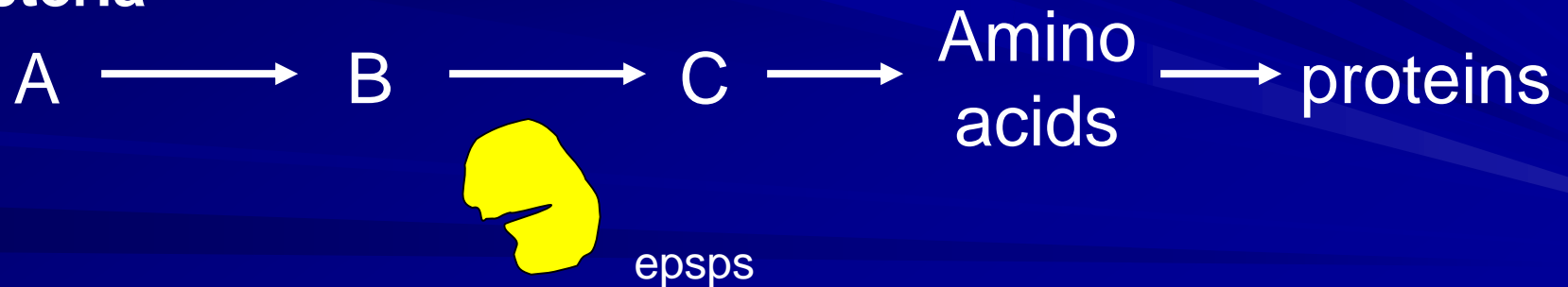


# How Herbicide Resistance Works

## Plants



## Bacteria



# How Herbicide Resistance Works

## Plants



glyphosate

**Resistance!**

## Advantages

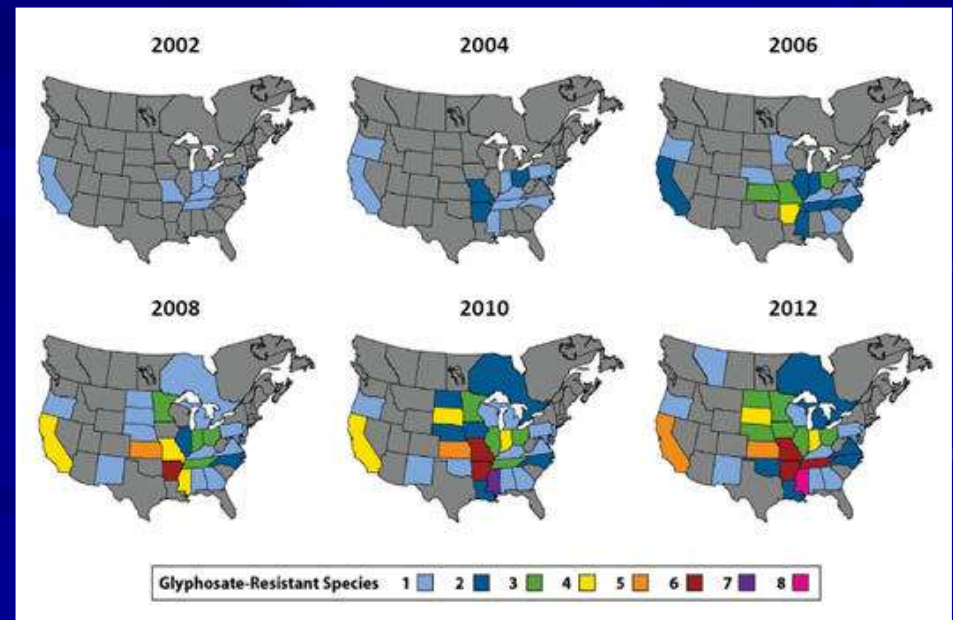
Switch to a low-toxicity herbicide, cheap and effective

Lower fuel and labor costs for farmers

Decreased tilling, saved topsoil

## Limitations

Weeds can evolve resistance, requiring increased labor, lower yields, and new control strategies. New chemistries.



# Crop Biotechnology 2.0

What is in the pipeline opportunities are lost because of the rigorous, time consuming and expensive deregulation process?

# *Colletotrichum* Crown Rot

*C. gloeosporioides*

Preliminary Results

Non-trans H4

NPR1-28



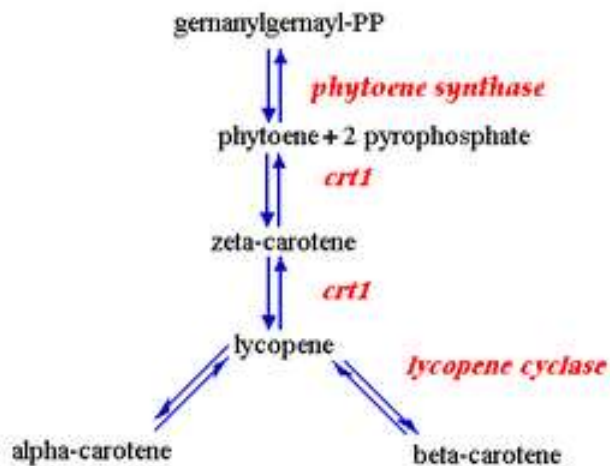
**Figure 6** Phenotype of the *Colletotrichum* Crown Rot on the transgenic plants. Plants with 25 DAI.



# Golden Rice



Opposition to golden rice cost \$2 billion to farmers in developing countries and 1.4 million human years – Wesseler et al., 2014



- 250,000-500,000 children go blind each year
- Half of them die within 12 months of losing their sight
- 1.9-2.7 million deaths per year may be due to VAD
- Impoverished families cannot afford vitamin A-rich food sources
- Supplementation is expensive and limited in effectiveness

**Farmers**

**Consumers**

**Environment**

**X**

**Needy**

# Cassava

250 million depend on cassava

50 million tons lost to virus.



Virus Resistant Cassava (VIRCA)

Biocassava Plus (BC Plus)

X

**Farmers**

**Consumers**

**Environment**

X

**Needy**

## Maize that Resists Drought



Non transgenic

transgenic

Survives moderate drought, especially at key times like flowering  
It is based on overexpression of a maize stress gene

X

Farmers

Consumers

Environment

X

Needy

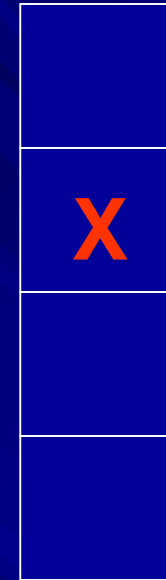


# Allergy-Free Peanuts

## Peanut – RNAi suppression Ara h2

Characteristics of Peanut Allergens

Allergen	Molecular Mass	Characteristics
Ara h 1	63 k-Da	Member of vicilin family of seed storage proteins, a 7S globulin
Ara h 2	17–19 k-Da	Member of conglutin family of seed storage proteins, a 2S albumin
Ara h 3	14–45 k-Da, processed from 64 k-Da protein	Member of glycinin family of seed storage proteins; heteromultimeric protein formed from differently proteolytically processed products of the same gene, an 11S globulin
Ara h 4	37 k-Da	Isoform of Ara h 3
Ara h 5	15 k-Da	Member of profilin family of G-actin-binding proteins
Ara h 6	15 k-Da	Member of conglutin family of seed storage proteins, a 2S albumin
Ara h 7	17 k-Da	Member of conglutin family of seed storage proteins, a 2S albumin
Ara h 8	16 k-Da	Homologous to major birch pollen allergen, Bet v 1 and other pathogenesis-related proteins
Ara h 9	9.8 k-Da	Lipid transfer protein
Ara h 10	16 k-Da	Oleosin seed storage protein
Ara h 11	14 k-Da	Oleosin seed storage protein

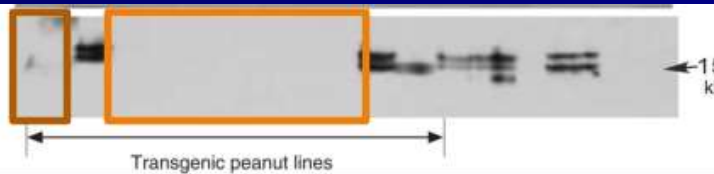


Farmers

Consumers

Environment

Needy



Plant tested	Two letter code	Ara h 2 protein concentration
Wild Type	WT	27.73%
12.1.1	S1	4.24%
32.1.1	S2	3.08%
45.6	S3	4.04%

# BS2 Tomato

A pepper gene in tomato eases black spot and wilt.



**X**

**Farmers**

**Consumers**

**X**

**Environment**

**Needy**



# High Anthocyanin Tomato

A transcription factor excites anthocyanin production in fruits



Longer shelf life too.



X

Farmers

X

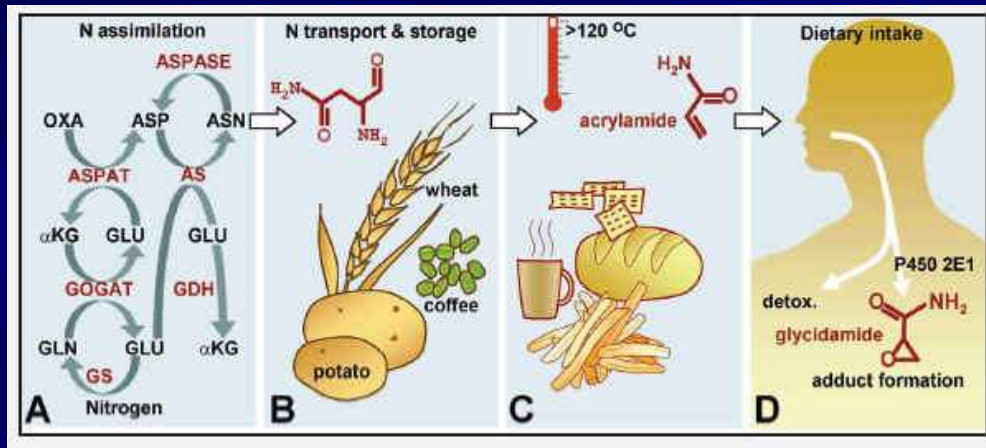
Consumers

Environment

X

Needy

# Low Acrylamide, non Browning Potatoes



X

Farmers

X

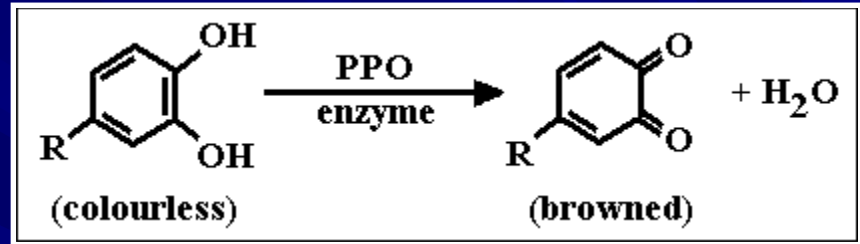
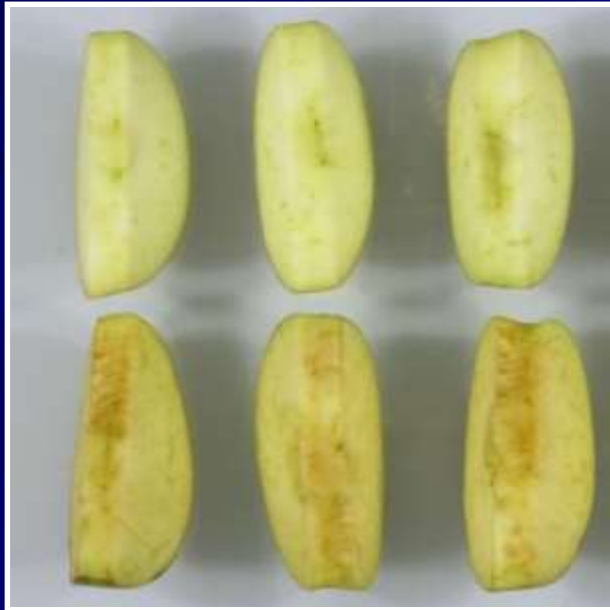
Consumers

Environment

Needy

# Non Browning Apples

Silencing a gene that leads to discoloration



**X**

**Farmers**

**X**

**Consumers**

**Environment**

**Needy**

**X**

**Small Business!**



# Grapes resistant to Pierce's Disease



**X**

**Farmers**

**X**

**Consumers**

**X**

**Environment**

**Needy**

# Bt Brinjal<sub>R1</sub>



Non-infested fruit of Bt Uttara



Infested fruit and shoot of non-Bt Uttara



**Today**



12

**Tomorrow**



- PUFA's: long chain poly-unsaturated fatty acids (ARA, EPA, DHA)
- Nutritional supplement to prevent cardiovascular diseases and arteriosclerosis
- Recommendation: 1 to 2g per day
- Main source today: fish, fish oil, algae
- Project target is to grow PUFA's in oil crops

**One acre of omega-3 producing soybeans yields as much oil as 10,000 fish!**

# Stopping Citrus Greening



Spinach defensin

Other plant genes

Many show promise

Earliest deregulation is  
2019



# Restoring the American Chestnut?



Chestnut blight has destroyed the American Chestnut.

A single gene confers resistance to the disease.

Not food... so deregulation is an interesting question.

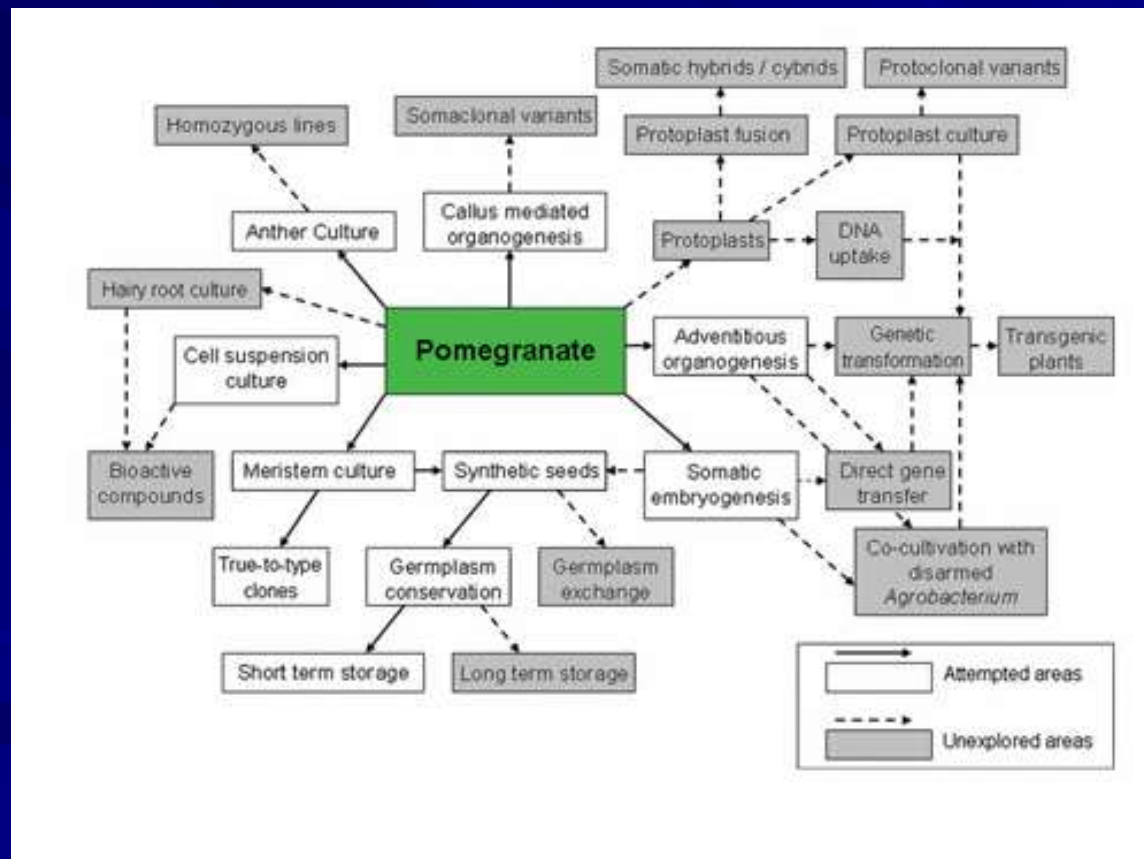
*What are the big issues in pomegranate?*

*Breeding is an important step to develop new varieties as foundation for future transgenic events*

- *Disease resistance?*
- *Flowering time?*
- *Abiotic stress?*
- *Chilling requirement?*
- *What else?*

***“It is better to have it and not need it, than to need it and not have it.”***

***Should understanding the in-vitro biology of pomegranate be a priority?***





Thank you.

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I'm always happy to answer your questions by email or phone