



HOW ROUNDUP READY[®] CANOLA WORKS

Using modern biotechnology, Monsanto has developed Roundup Ready canola (*Brassica napus*) plants that are tolerant to glyphosate, the active ingredient in Roundup[®] brand herbicides. Glyphosate is an inhibitor of 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), a well-known enzyme of the shikimate pathway for aromatic amino acid biosynthesis that is common in plants, fungi and bacteria.

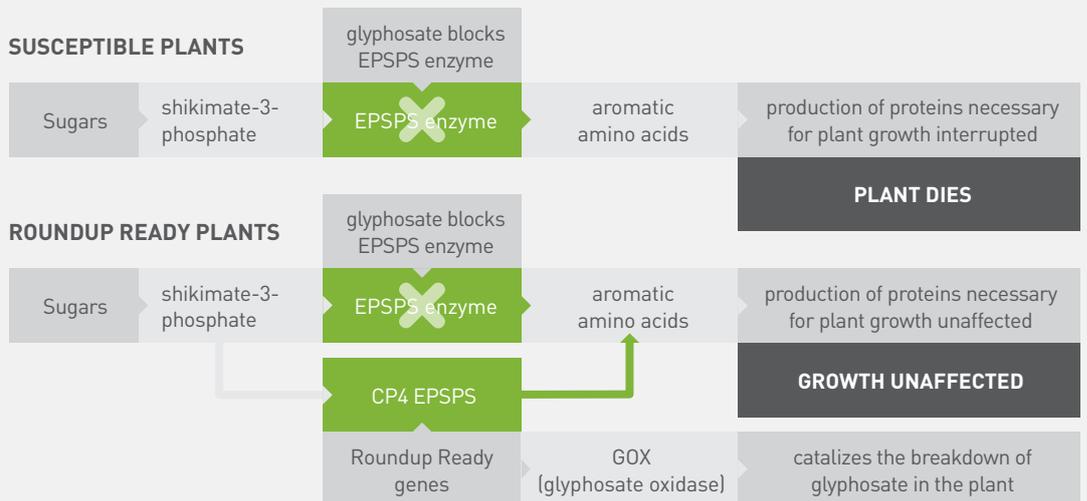
Plants, including weeds, exposed to glyphosate are unable to produce aromatic amino acids and hence die. To produce Roundup Ready canola, two genes were introduced into the canola genome:

- The cp4 epsps gene, derived from the common soil bacterium *Agrobacterium* strain CP4, which encodes for the production of the CP4 EPSPS enzyme.
- The gox gene from *Ochrobactrum anthropi* strain LBAA, which encodes for the production of the enzyme glyphosate oxidase (GOX).

Both the CP4 EPSPS and GOX proteins, are expressed at consistent levels in the plant, and together they provide tolerance to glyphosate (refer to figure below). Because CP4 EPSPS has a naturally high tolerance to inhibition by glyphosate, Roundup Ready canola plants continue to produce aromatic amino acids even after treatment with glyphosate. In addition, the GOX protein.

The disarmed *Agrobacterium tumefaciens* plant transformation system was used to produce Roundup Ready canola line GT73 (White, 1989; Howard et al., 1990). This delivery system is well documented to transfer and stably integrate T-DNA into a plant nuclear genome (White, 1989; Howard et al., 1990).

Only the DNA required to confer the glyphosate-tolerance phenotype was transferred and inserted at a single locus in the canola genome. A single chromosomal copy of the DNA is present in event GT73 and has been stably inherited across multiple generations. Moreover, the consistent commercial performance of Roundup Ready canola further supports the stability of the inserted DNA and functioning of the CP4 EPSPS and GOX proteins.



The action of CP4-EPSPS in allowing Roundup Ready canola to tolerate applications of Roundup Ready Herbicide with PLANTSHIELD by Monsanto, whilst susceptible plants cannot produce essential amino acids and, therefore, senesce.



Crop Tolerance

Roundup Ready canola displays vegetative tolerance to Roundup Ready Herbicide with PLANTSHIELD® by Monsanto. This vegetative tolerance is present throughout the recommended application window at the recommended rates. Occasionally, some short-term yellowing of the crop may occur. This effect is temporary and will not effect crop growth or yield.

Reproductive or floral tolerance is relatively low and unpredictable. Any time background levels of glyphosate (the active ingredient in Roundup Ready Herbicide with PLANTSHIELD® by Monsanto) are above a critical level, and flowers are in the pollen development stage, sterility will occur.

There will be no pollen development and, therefore no successful fertilisation, resulting in pod abortion. The extent of this damage may vary depending on environmental conditions. However, there is strong evidence that crop maturity may be delayed, quality compromised and yield significantly reduced.

To ensure that the background level of glyphosate is below the critical level, Roundup Ready canola should not be sprayed after the six true leaf stage (provided this is before the commencement of reproductive development). Where plants have not yet reached the six true leaf stage, but they are beginning reproductive development (shown by stem elongation or bud formation) Roundup Ready Herbicide with PLANTSHIELD® by Monsanto should not be applied.

It is important to highlight that the excellent vegetative crop safety of Roundup Ready canola can be compromised by spraying under stressed conditions. In the same way that weed control can decrease by spraying stressed weeds, so too can crop effects increase by spraying stressed crops. Stress can be caused by numerous environmental and biological factors including: drought, water logging, low light intensity, high or low temperatures, frost, nutrient deficiencies and insect or disease attack.

SUMMARY

- Roundup Ready canola is the same as conventional canola – except for its ability to tolerate 'over-the-top' applications of Roundup Ready Herbicide with PLANTSHIELD by Monsanto during the vegetative stage.
- This tolerance comes through the activity of two enzymes – one which provides an alternate EPSP synthase, and the second which degrades the glyphosate.
- Spray Roundup Ready canola with Roundup Ready Herbicide with PLANTSHIELD by Monsanto at any stage up to and including the six true leaf stage (prior to bud formation).
- Avoid spraying Roundup Ready canola crops which are stressed.

For further information on Roundup Ready canola, or to find your local Technology Service Provider (TSP) visit www.roundupreadycanola.com.au

