

HERBICIDE RESISTANCE

- ✓ Weeds are unwanted & useless plants that grow along with the crop plants .
- ✓ Weeds compete with the crops for light & nutrients, besides harboring various pathogens .
- ✓ So it is estimated that the worlds crop yield is reduced by 10 – 15 % due to the presence of weeds.
- ✓ To tackle the problem of weeds , modern agriculture has developed a wide range of weed killers (herbicides) .
- ✓ Herbicides are broad spectrum as they can kill wide range of weeds.

An ideal herbicide is to possess the following characters : -

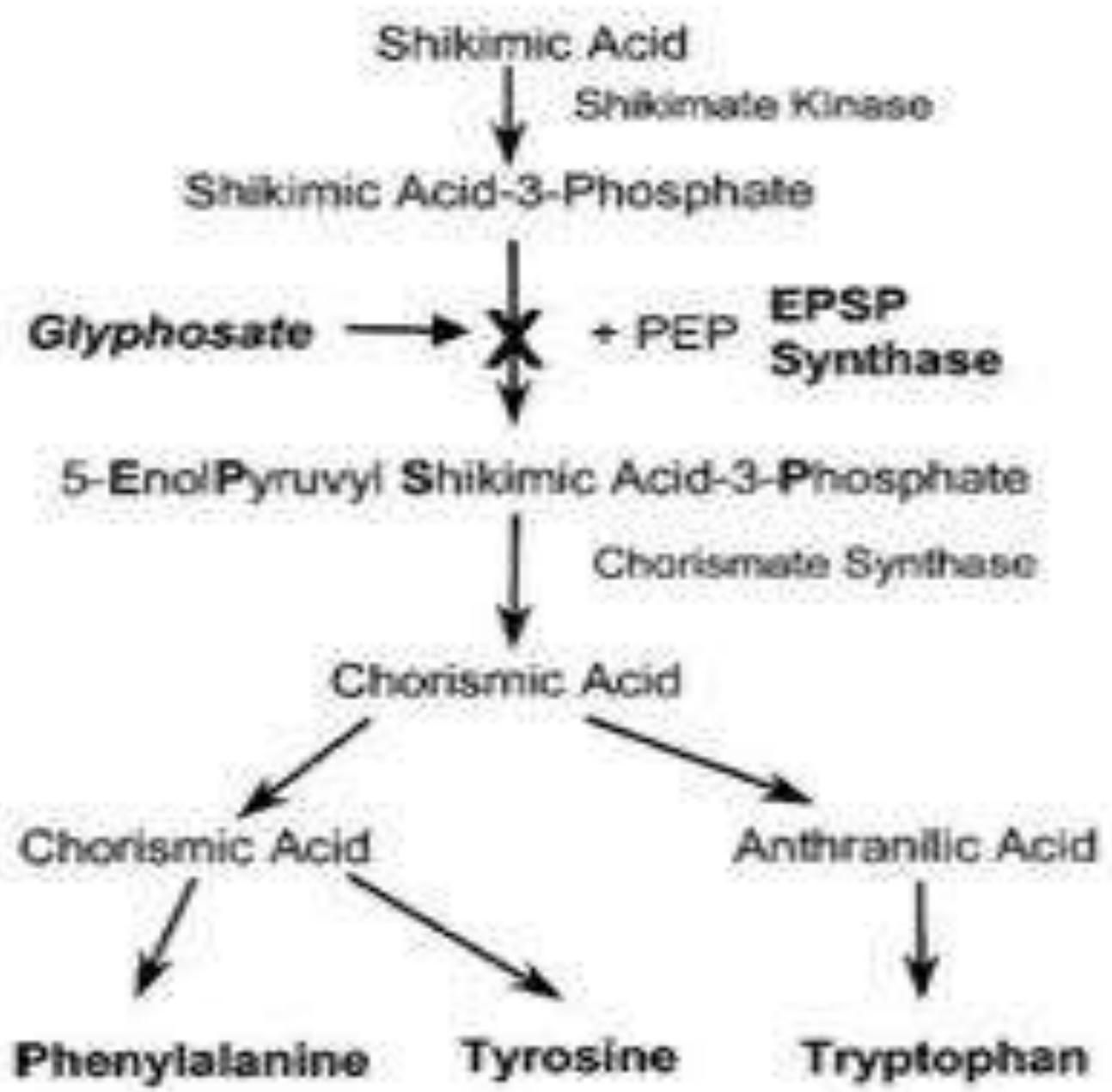
1. Capable of killing weeds without affecting crop plants
 2. Not toxic to animals & microorganisms
 3. Rapidly translocated within the target plant
 4. Rapidly degraded in the soil
- ✓ Commercially available herbicides is that they can not discriminate weeds from the crop plants .
 - ✓ For this reason , crops are also affected by herbicides hence the need to develop herbicide resistance plants

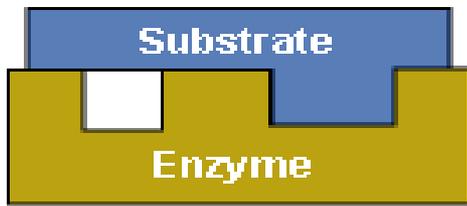
Glyphosate

- ✓ It is a broad spectrum herbicide , effective against 76 of worlds worst 78 weeds .
- ✓ Less toxic to animals , is rapidly degraded & short life span .
- ✓ The american company (Monsanto) market it as round up .

Mechanism of Glyphosphate action :-

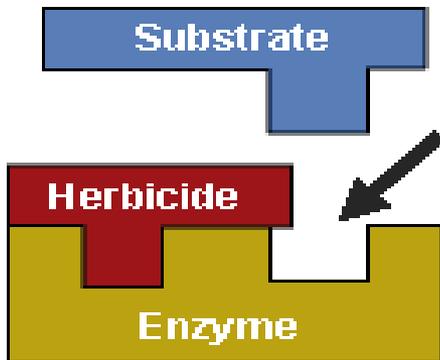
- ✓ Capable of killing the plants in low conc .
- ✓ Rapidly transported to growing tissues .
- ✓ It is competitive inhibitor of EPSPS (a key enzyme shikimic acid path way





Amino Acids: Plant Lives

2A

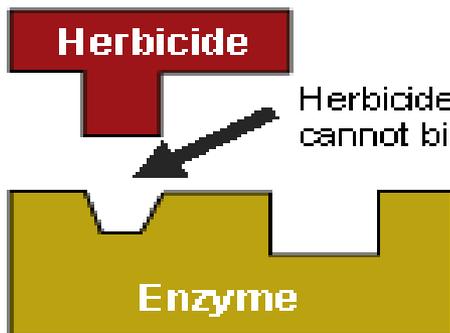


Substrate cannot bind.



No Amino Acids: Plant Dies

2B



Herbicide cannot bind.



2C



Amino Acids: Plant Lives

- ✓ Shikimic acid pathway results in the formation of aa, phenols , metabolites .
- ✓ Glyphosate binds with EPSPS & blocks metabolism (sa) .
- ✓ Thus biosynthesis of aa & other products are inhibited .
- ✓ So cell division & plant growth are blocked .
- ✓ S pathway doesn't occur in animals .
- ✓ So it is not toxic to animals

ADVANTAGES OF USING HERBICIDES

- Broad spectrum of weeds controlled
- Reduced crop injury
- Reduced herbicide carryover
- New mode of action for resistance management
- Crop management flexibility and simplicity
- Use of herbicides that are more environmentally friendly

Disadvantages of herbicides

- Mammalian toxicity
- Eco toxicity
- Weeds become super weeds
- Reduced crop yield
- Creates soil and air pollution

Strategies for engineering herbicide resistance

A no. of biological manipulations involved in genetic eng are in use to develop herbicide resistance plant

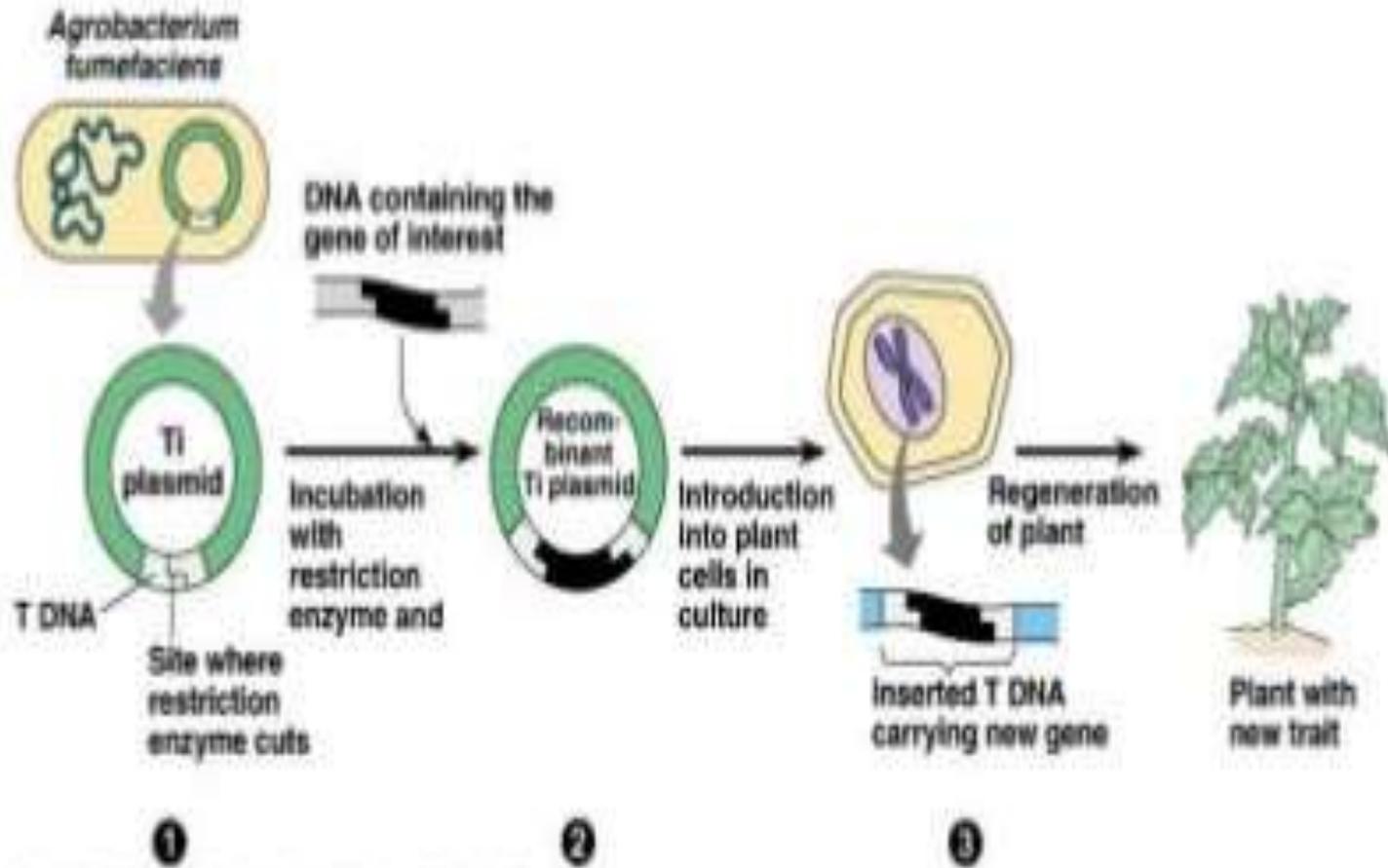
1. over expression of EPSPS gene
2. use of mutant EPSPS gene
3. detoxification of herbicide by a foreign gene

Glyphosate resistance in crop plants :-

1. Over expression of EPSPS gene :-

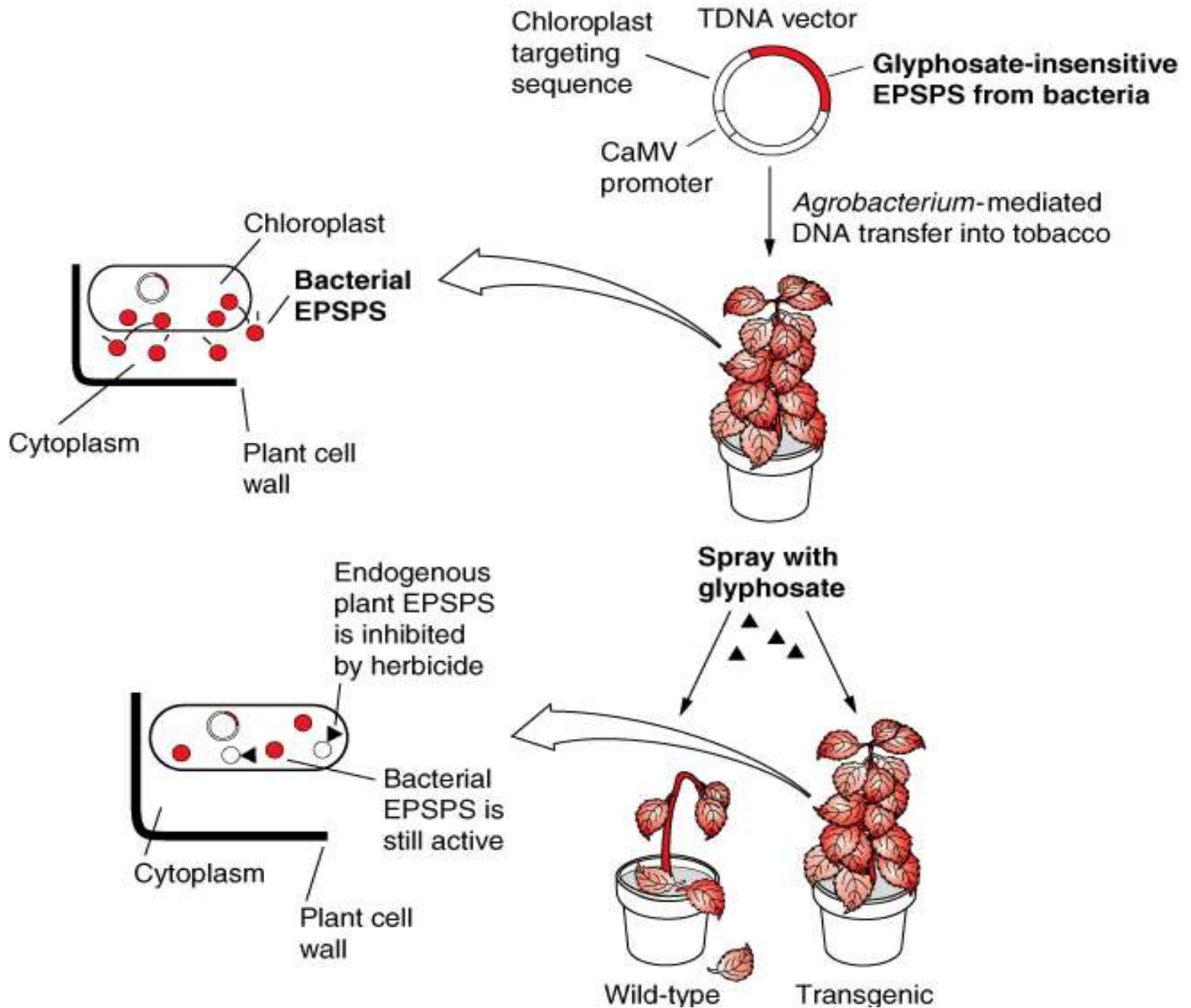
An over expression gene of EPSPS was detected in petunia . Gene from petunia was isolated & introduced in to other plants . The transgenic plants can tolerate glyphosphate 2 -4 times higher than that required to kill wild type weed plants

Transfer of petunia gene into bacterium and then into plant



2. Use of mutant EPSPS :-

- ❑ EPSPS mutant gene resistant to glyphosphate was found in *S. typhimurium* it was found that single base substitution (C to T) change in aa from proline to serine. This enzyme can not bind to glyphosphate
- ❑ using agrobacterium as vector mutant EPSPS was introduced in to tobacco plants but this is failed . It was later known that s . Pathway occurs in chloroplast, mutant EPSPS was produced in cytoplasm . This gene is not capable of transported to chloroplast .
- ❑ Later years mutant EPSPS gene was tagged with chloroplast specific transit EPSPS enzyme that freely enter chloroplast & confer resistance against herbicide



3. Detoxification of glyphosphate :-

The soil microorganisms possess enzymes glyphosphate oxidase that converts glyphosphate to glyoxylate. The gene was isolated from *ochrobactrum anthropy* & was introduced into crop plants

e.g: oil seed rape

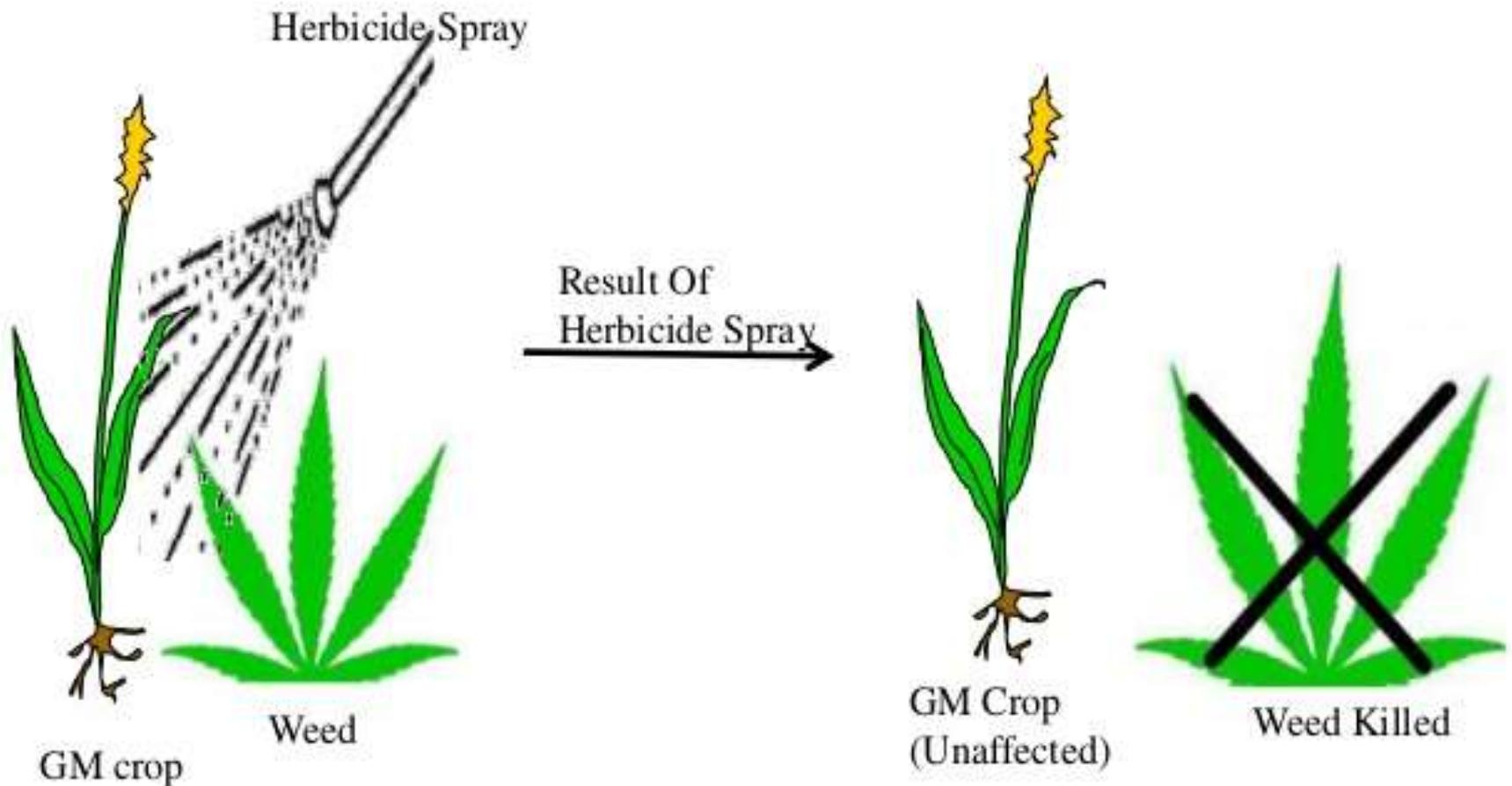


Use of combine strategy :-

High resistance is acquired when the above 3 strategies combine together by this approach mutant , detoxification ,over expression genes were employed in the same organism thus provides resistance

Herbicide Tolerance

- Over 63% of Gm crops grown globally have herbicide tolerance traits.
- Herbicide tolerance is achieved through the introduction of a gene from a bacterium conveying resistance to some herbicides. In situations where weed pressure is high, the use of such crops has resulted in a reduction in the quantity of the herbicides used.



Most Important Herbicide-Resistant Species

1. Rigid Ryegrass *Lolium rigidum*
2. Wild Oat *Avena fatua*
3. Redroot Pigweed *Amaranthus retroflexus*
4. Common Lambsquarters *Chenopodium album*
5. Green Foxtail *Setaria viridis*
6. Barnyardgrass *Echinochloa crus-galli*
7. Goosegrass *Eleusine indica*
8. Kochia *Kochia scoparia*
9. Horseweed *Conyza canadensis*
10. Smooth Pigweed *Amaranthus hybridus*

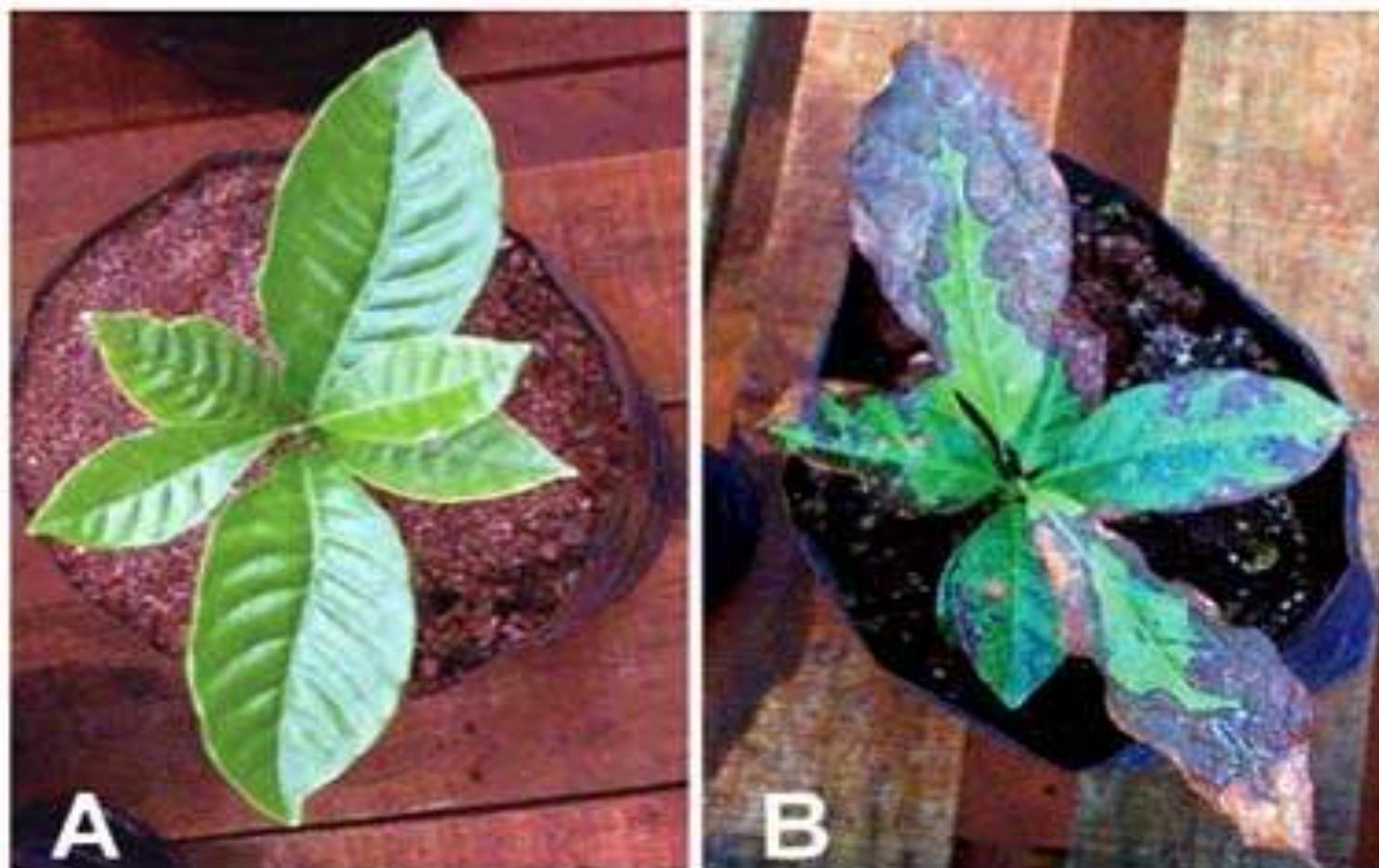


Figure 1. Herbicide tolerant coffee plant (A) and non-transformed plant (B), one week after spraying with ammonium glufosinate at 200 mg.L^{-1} (Ribas et al., 2006).



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Thanks!