TARGET SITE HERBICIDE RESISTANCE

WHAT IS IT?

How is resistance acquired?

- Changes in the nucleotide sequence (instructions), also known as mutations, that are responsible for creating the target site (end product).
- Mutations can present in different ways for example, as deletions (part of the instructions are deleted), substitutions (part of the instructions are replaced) or duplications (part of the instructions are copied to another part).

What is target site resistance?

• The target site is where the herbicide acts. In target-site resistance, a change occurs to this site that prevents the herbicide from binding or interacting at its site of action. As a result, the effect of the herbicide is reduced or eliminated.

AN EXAMPLE USING 5-ENOLPYRUVYLSHIKIMATE-3-PHOSPHATE SYNTHASE (EPSPS)

- EPSPS is the target enzyme for glyphosate
- EPSPS is key in the shikimate pathway. The shikimate pathway produces products that are vital for plant growth and development

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MODIFICATION

What is it?

 Changing the target site so that the herbicide cannot access it, thus leaving the herbicide ineffective

Where does the mutation occur?

- Known EPSPS target site mutations are Pro-106 to Ser, Thr, Ala, or Leu
- Pro-106 provides part of the molecular structure at the active site
- Changing Pro-106 = changing spacing in the active site.

UP-REGULATION

EPSPS

What is it?

 Increased expression of the target site, there are extra gene copies in the DNA sequence which results in increased expression, requiring more herbicide

How does this happen?

- As a result of higher EPSPS mRNA (instruction) expression.
- More instructions = more products to create = more herbicide needed for the same effect





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TARGET SITE HERBICIDE RESISTANCE

AN EXAMPLE USING PROTOPORPHYRINOGEN OXIDASE (PPO)

- The PPO enzyme, is required for catalyzing the last step of plant heme and chlorophyll biosynthesis.
- The inhibition of the PPO enzyme leads to the accumulation of intermediates and eventually highly reactive oxygen species.

MODIFICATION

What is it?

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• Changing the target site so that the herbicide cannot access it, thus leaving the herbicide ineffective.

Where does the mutation occur?

- Deletion of a Gly codon at position 210
 - This is proposed to partially unravel an α-helix adjacent to the PPO active site, enlarging the active-site cavity.
- Substitutions of Arg-128 (or 98, depending on the numbering system) to Leu, Gly, or Met.

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FUN FACTS

- Target site mutations are easier to identify and understand.
- Management recommendations have been based on understanding of target site resistance
- The first DNA change conferring evolved target-site resistance to be confirmed was to triazines in 1983, over 25 years after the first report of herbicide resistance.
- One plant can have both target and non-target site mechanisms.
 - Typically test for target site first
 - Even if target site resistance is identified, it is also possible that there is non target site resistance.
- The most common target site mutation is in the ALS enzyme
 - Pro-197 mutations are one of the most frequent mutations in resistant plants.
 - 40% of ALS resistant species have this mutation

RESOURCES

1. <u>https://doi.org/10.1074%2Fjbc.REV120.013572</u> 2. <u>https://doi.org/10.3390%2Fplants8100382</u> 3. <u>https://doi.org/10.3390%2Fplants8100417</u> FUNDED BY:

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