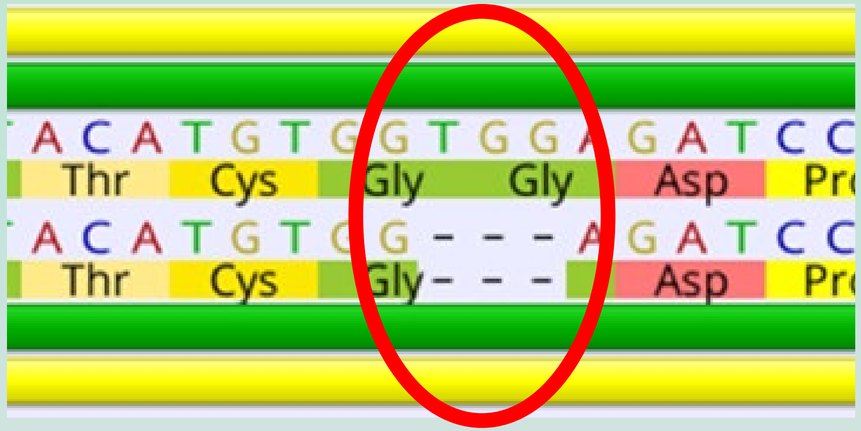
Rise of the mutant weed

GROW
NEXT GEN

The rise of the mutant weed



Goal 1

Locate potential mutations for herbicide resistance

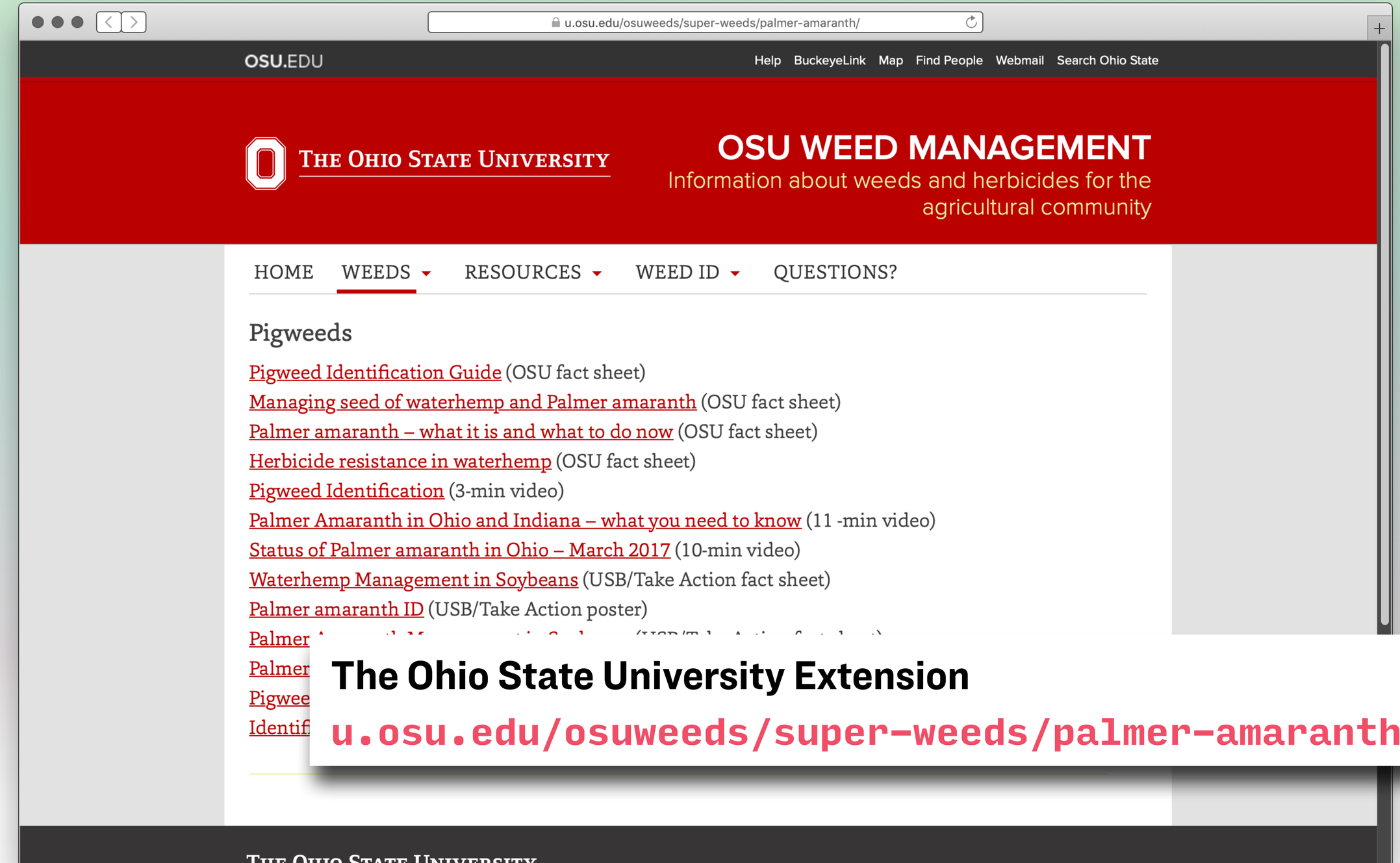
?!

Goal 2

Identify the species of pigweed

Pre-lecture questions

- What is a weed?
- How are weeds controlled?
- How might herbicide resistance happen?


u.osu.edu/osuweeds/super-weeds/palmer-amaranth/
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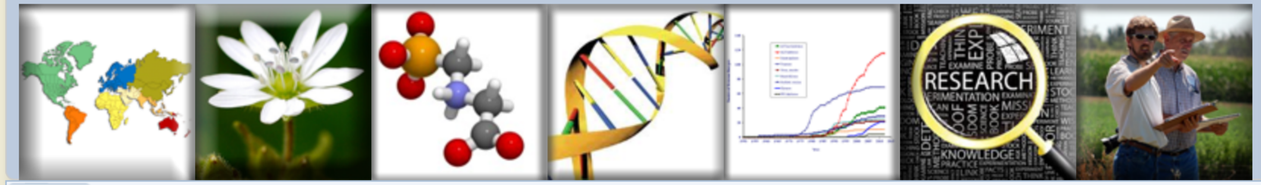
OSU WEED MANAGEMENT
Information about weeds and herbicides for the agricultural community
HOME WEEDS RESOURCES WEED ID QUESTIONS?
Pigweeds
Pigweed Identification Guide (OSU fact sheet)
Managing seed of waterhemp and Palmer amaranth (OSU fact sheet)
Palmer amaranth – what it is and what to do now (OSU fact sheet)
Herbicide resistance in waterhemp (OSU fact sheet)
Pigweed Identification (3-min video)
Palmer Amaranth in Ohio and Indiana – what you need to know (11 -min video)
Status of Palmer amaranth in Ohio – March 2017 (10-min video)
Waterhemp Management in Soybeans (USB/Take Action fact sheet)
Palmer amaranth ID (USB/Take Action poster)
The Ohio State University Extension
u.osu.edu/osuweeds/super-weeds/palmer-amaranth

Not Secure — weedscience.org/summary/moa.aspx?MOAID=12

INTERNATIONAL SURVEY OF HERBICIDE RESISTANT WEEDS



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Resistant Weeds
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- By Crop

Drag a column header and drop it here to group by that column

Weeds Resistant to Inhibition of Enolpyruvyl Shikimate Phosphate Synthase (G/9)
by species and country

#	Species	Country	First Year
1	***Amaranthus hybridus (syn: quitensis)*** Smooth Pigweed	2013 - Argentina 2014 - Argentina *Multiple - 2 SOA's 2016 - Argentina *Multiple - 2 SOA's 2018 - Brazil *Multiple - 2 SOA's	**2013**
2	***Amaranthus palmeri*** Palmer Amaranth	2005 - United States (Georgia) 2005 - United States (North Carolina) 2006 - United States (Arkansas) 2006 - United States (South Carolina) 2006 - United States (Tennessee) 2007 - United States (New Mexico) 2008 - United States (Alabama) 2008 - United States (Georgia) *Multiple - 2 SOA's 2008 - United States (Mississippi) *Multiple - 2 SOA's 2008 - United States (Missouri) 2009 - United States (Tennessee) *Multiple - 2 SOA's 2010 - United States (Georgia) *Multiple - 3 SOA's 2010 - United States (Illinois) 2010 - United States (Kentucky) 2010 - United States (Louisiana) 2011 - United States (Virginia) 2012 - United States (Arizona) *Multiple - 2 SOA's 2012 - United States (Delaware) 2012 - United States (Indiana) 2013 - United States (Florida) 2013 - United States (Florida) *Multiple - 2 SOA's	**2005**

weedscience.org/summary/moa.aspx?MOAID=12

Herbicide resistance is an increasing issue

Unrestrained weed growth would **reduce crop yield by 50%** across US and Canada

[The bill = $43 billion annually]

Amaranths (pigweeds)

- **Prolific seed producer:** 100,000s of seeds
- Dispersed by wildlife, flooding, farming equipment
- **Fast growth rate** (up to 4 inches per day)
- Up to 78% **yield loss** in soybeans
- **Herbicide resistant**

Hard to identify young pigweeds





Hard to identify young pigweeds

PALMER AMARANTH

WATERHEMP

REDROOT PIGWEED

SMOOTH PIGWEED

POWELL AMARANTH

Pigweed seeds

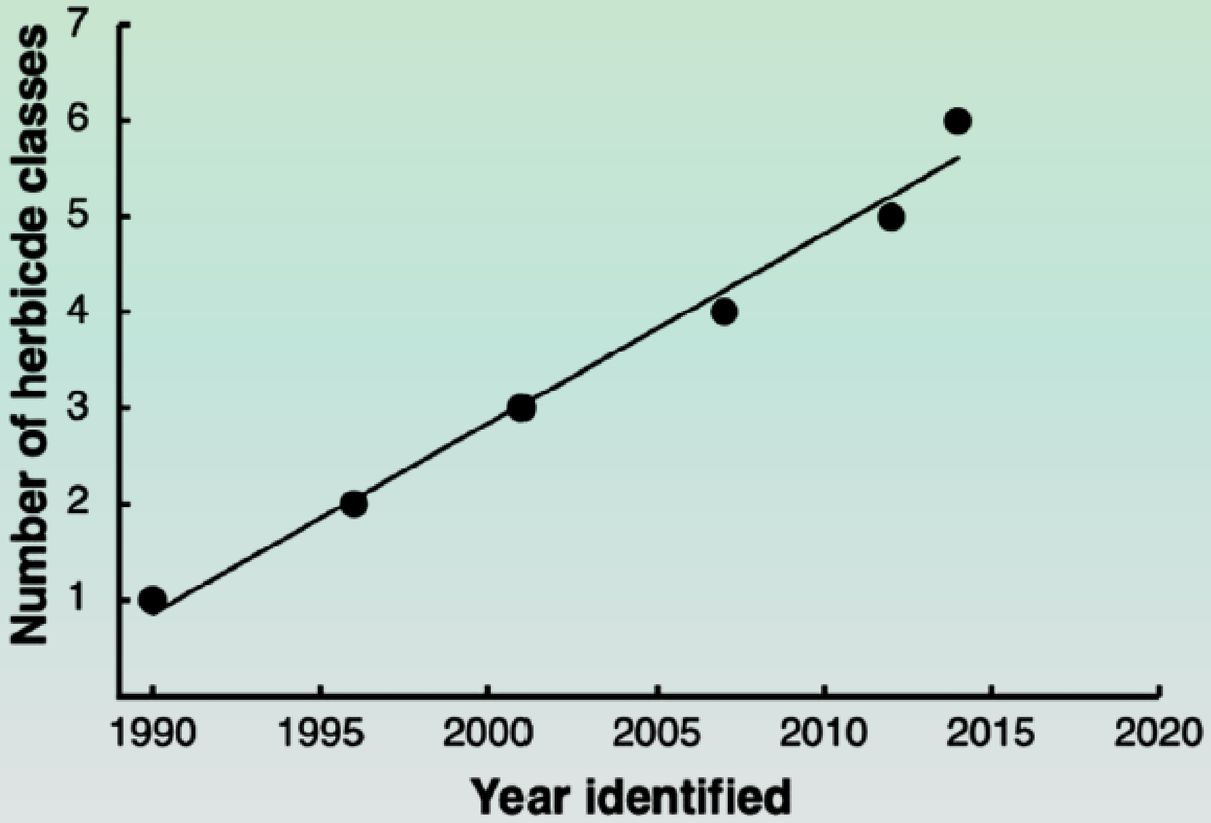


Figure 4. First observances of resistance to increasing numbers of herbicide classes in *Amaranthus tuberculatus* over time. Each herbicide class has a different site of action. In all cases except for five-way resistance, resistance to multiple classes was demonstrated to occur within individual plants (in addition to within the population). Data are plotted from resistance cases shown in Fig. 3.

Increasing resistance in pigweeds to multiple classes of herbicides

Source: onlinelibrary.wiley.com/doi/full/10.1002/ps.6048

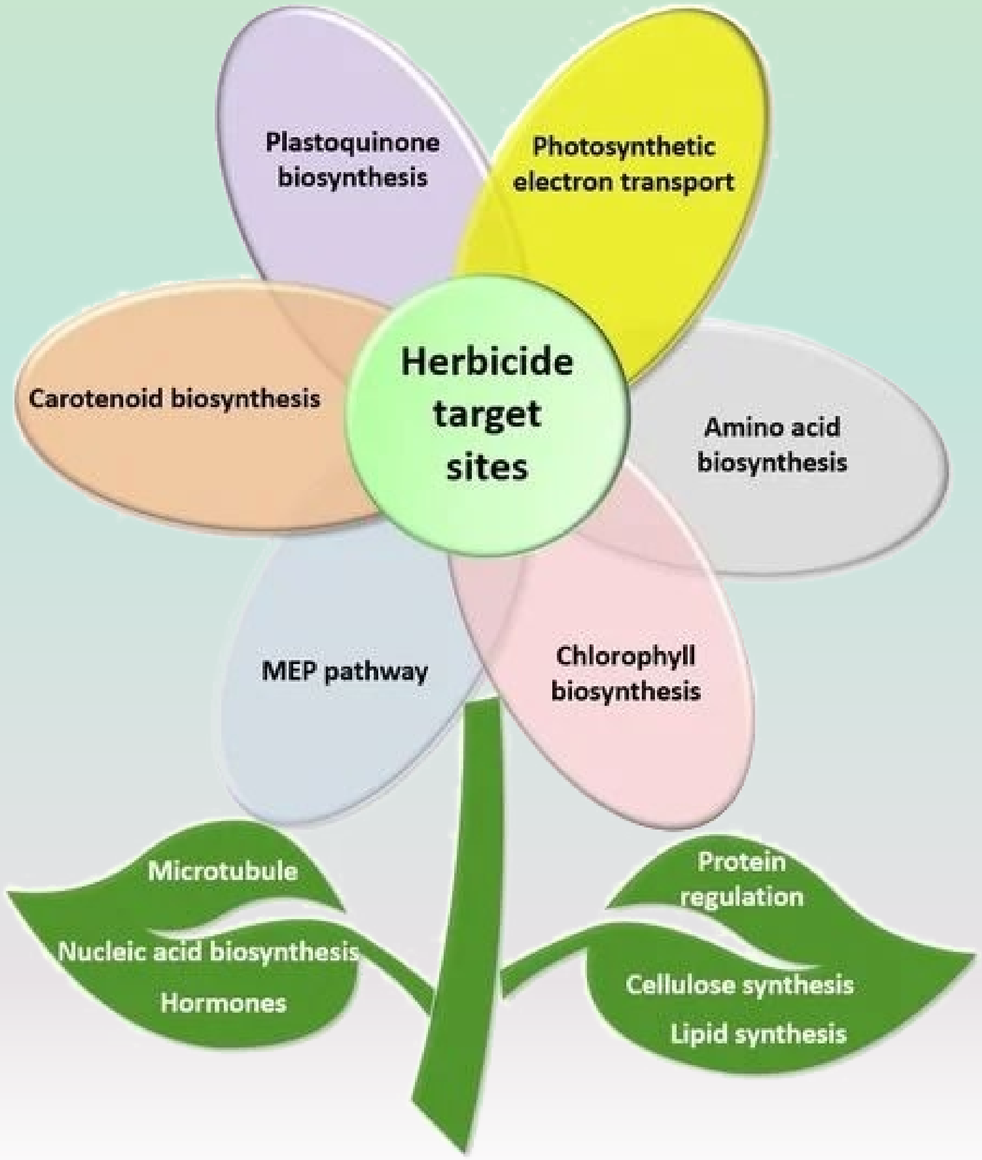
Two types of herbicide resistance

1. Target-site mechanism (most common)

- Herbicide must bind to target to be effective
- Change in target reduces herbicide action

2. Non-target site mechanism

- Metabolic resistance
- Plant breaks down chemical before it reaches its target



The rise of the mutant weed

A **weed scientist** has collected pigweed seeds from a sunflower processing factory and planted them in the greenhouse. After emergence, she sprayed them with PPO-inhibiting herbicide. After 10 days, she noticed several plants that were resistant.

She sent a leaf sample to the **diagnostic lab** and received back the DNA sequences for the gene that codes for the protein that the herbicide targets. Your job is to identify the species of pigweed and find mutations that may provide herbicide resistance.

Aims of activity

Use the web-based program to:

- Upload fasta sequences for analysis
- Upload a library containing known sequences from various pigweed species
- Use MUSCLE, a bioinformatics tool, to align the unknown sequence with the library of known sequences to search for mutations
- Use PHYLIP, a bioinformatics tool, to make a simple phylogenetic tree to identify the pigweed species of the unknown sample.

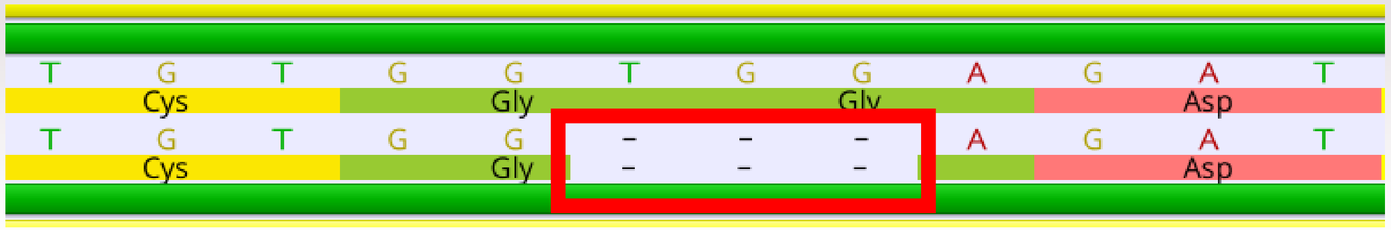
Genetic basis for herbicide resistance within the *PPX2L* gene

Missing amino acid in mutant

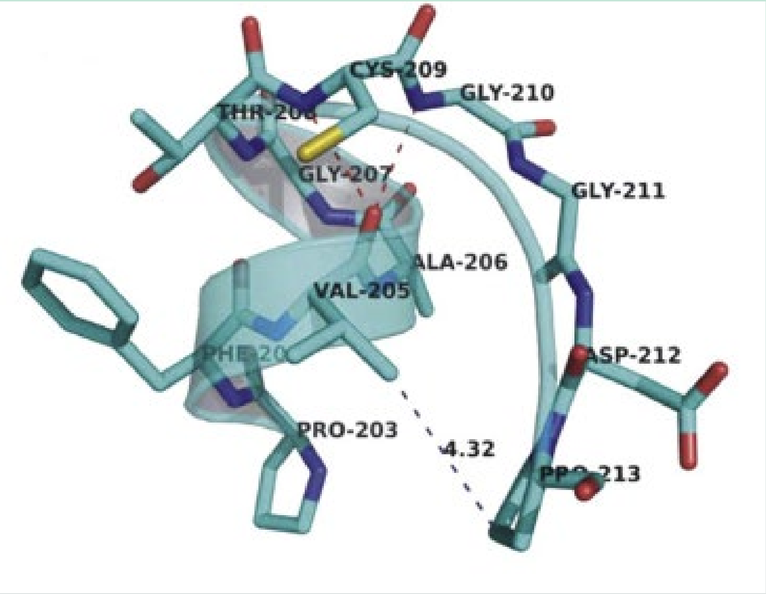
ΔG210

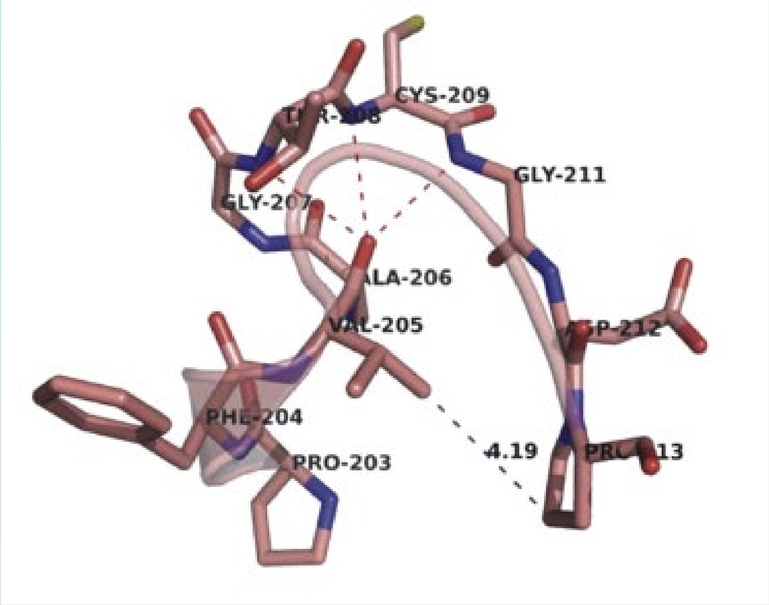
Wildtype sequence

Mutant sequence



Protein target of PPO-inhibiting herbicides (PPO molecule)





structure = function

Wildtype protein:
Only space for the herbicide molecule

Mutant protein:
Large gap rendering the herbicide less effective