

## Photosynthesis & Pigment Synthesis Inhibitors

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### 1. Photosynthesis II (PSII) Inhibitors

#### **Uptake & Translocation**

Chemistry: Lipophilic – penetrates cuticle

Basic molecules - Xylem mobile only --> Transpiration stream

#### **Mode & Mechanism of action**

PSII inhibitors compete with plastoquinone (PQ) at QB binding site of D1 protein

- Blocks electron flow through photosynthesis
- Creation of reactive oxygen species (ROS)
- ROS damage membranes

**Resistance** <http://www.hracglobal.com/>

#### **HRAC Group 5**

Triazines (atrazine, simazine), Triazinones, Triazolinones, Uracils, Pyridazinones, Phenyl-carbamates

#### **HRAC Group 6**

Nitriles (bromoxynil), benzothiadiazinones, phenyl-pyridazines

#### **HRAC Group 7**

Ureas (diuron), Amides

#### **Resistance: Known mechanisms**

Target site resistance: Mutation does not favor binding

Metabolism: Less common - Crop tolerance & selectivity

#### **Symptomology**

- Soil Applied Symptoms: Initial injury = first photosynthetic leaves  
Chlorosis leaf margins & older leaves
- Foliar Applied Symptoms: Chlorosis & necrosis at leaf tips, older leaves first
- Injury and carryover: greater with late application, dry season, & soil pH >7.2



### 2. Pigment synthesis Inhibitors

#### **Mode of action**

- Depletion of antioxidants (plant protective pigments)
- Increases damage from reactive oxygen (ROS)
- Damages membranes & cellular compartments

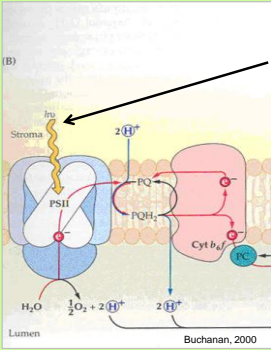
#### **Uptake & translocation**

- Weak acids: Penetrate cuticle - Phloem-trapped
- Translocated through phloem to new tissues

## Mechanism of action

- HPPD inhibitors: Depletes tocopherols, carotenoids, & plastoquinone
- 1-deoxyxylulose-5-phosphate synthase (DOXP5) inhibitors: Deplete carotenoids & plastoquinone
- Phytoene desaturase (PDS) inhibitor: Depletes carotenoids
- Lycopene cyclase inhibitor: Depletes carotenoids

### PSII Inhibitors

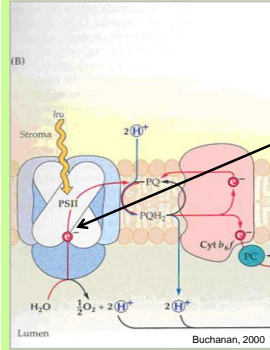


**Photosynthesis review**

- Photosystem II (PSII) – first site to accept light energy
- Energy from light drives electron (e<sup>-</sup>) transfer
- Plastoquinone used to carry electrons to next protein (Cytochrome B<sub>6</sub>f)

Buchanan, 2000

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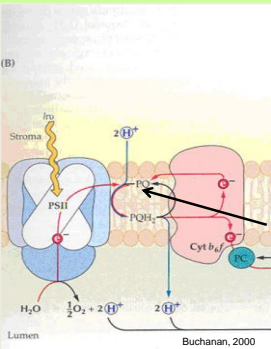


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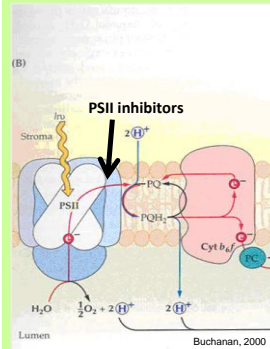


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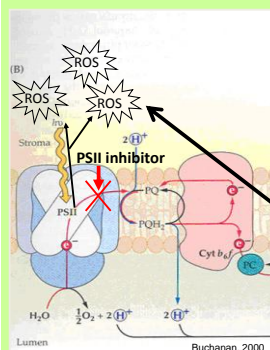


**Mechanism of action**

- PSII inhibitors compete with plastoquinone (PQ) at Q<sub>B</sub> binding site of D1 protein
- Blocks electron transfer through photosynthesis

Buchanan, 2000

### PSII Inhibitors



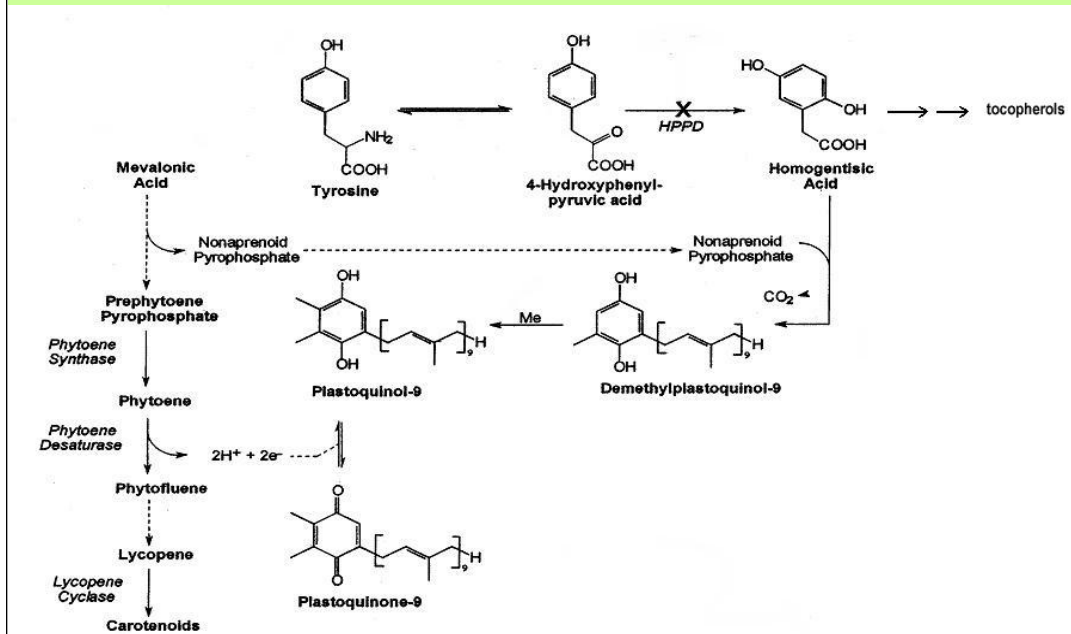
**Mechanism of action**

- Compete with plastoquinone (PQ) as an e<sup>-</sup> acceptor at Q<sub>B</sub> binding site of D1 protein
- Blocks electron transfer through photosynthesis
- Generates reactive oxygen species (ROS)
- ROS damage cell walls
- Antioxidants
  - partial ROS protection
  - (tocopherols (Vit. E), carotenoids)

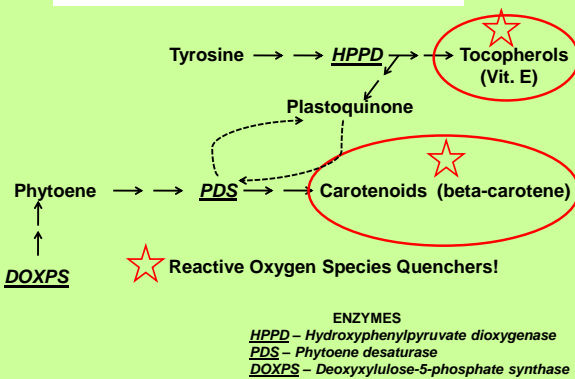
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# Pigment synthesis Inhibitors

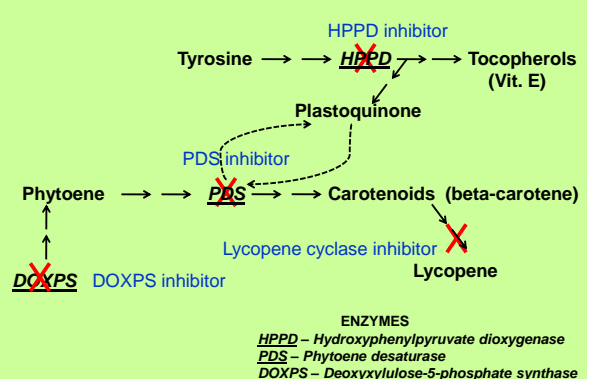
## A QUICK BIOCHEMISTRY LESSON



### Pigment synthesis Inhibitors



### Pigment synthesis Inhibitors



## Resistance

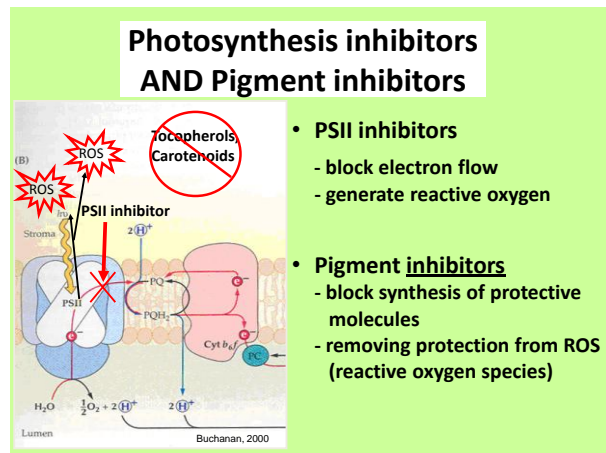
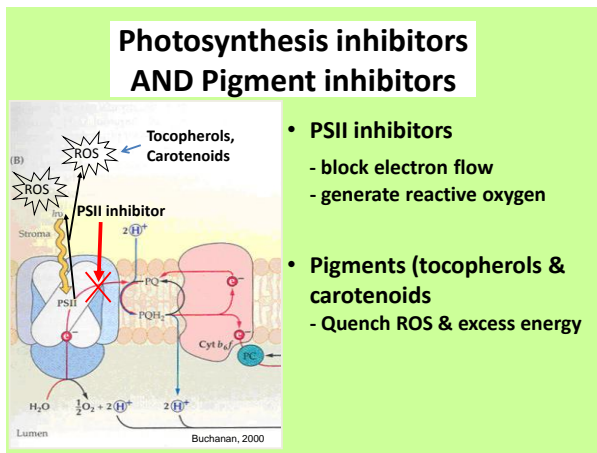
- HRAC Group 11 (*lycopene cyclase*)  
Triazoles (amitrole)
- HRAC Group 12 (*phytoene desaturase*)  
Pyridazinones (norflurazon), pyridinecarboxamides, 'other' - fluridone
- HRAC Group 13 (*unknown*)  
Isoxizolidinones (DOXP synthase inhibitor), Ureas, Diphenyl ethers
- HRAC Group 27 (*HPPD*)  
Triketones (mesotrione), isoxazoles, pyrazoles



## Symptomology

- New tissue chlorotic or white
- Bleached tissue - necrotic

## 3. Interaction of PSII & Pigment inhibitors



## 4. Summary

- **Photosystem II (PSII) inhibitors**
  - Xylem mobile
  - Block electron transfer
  - Reactive species generation
  - Necrosis on leaf margins, older leaves
- **Pigment synthesis inhibitors**
  - Phloem mobile
  - Block antioxidant synthesis
  - Increased Reactive Oxygen Species damage
  - Chlorotic or bleached young tissue