

Weed Science, PLS 4601c Section 7644
and Grad. – Prin. Of Weed Science AGR 6932 Section 9212
University of Florida - Davie

<http://grove.ufl.edu/~turf/weedscience/>

Philip Busey, turf@ufl.edu
954-579-3932 (cell)

June 29, 2009

Herbicides

Introduction

Define herbicide

Is an herbicide a type of pesticide?

What are the other types of pesticides?

History

What were the first herbicides, 1900-1941? - Bordeaux mixture (lime-copper-sulfur mixture) about 1900 (mostly fungicide), arsenicals, chlorates, borates, and others.

When were synthetic herbicides first developed? - 1941

What was the first synthetic herbicide and what was its intended purpose?

What was the role of Rachel Carson's book, "Silent Spring" in the regulation of pesticides?

What year was it published?

What year was the EPA founded?

Use characteristics of herbicides

Activity: contact vs. systemic

Use: preemergence herbicides (PRE) vs. postemergence herbicides (POST)

Foliar vs. soil-applied

Translocation: symplastic, apoplastic, nontranslocated

Effects on weeds: control vs. suppression

Chemistry of herbicides

What are the functional groups?

What are the families of herbicides?

What are the mechanisms (and sites) of action of herbicides?

What are the chemical characteristics of herbicides? (solubility, toxicity, volatility, selective vs. nonselective, by families) , e.g., photosystem II inhibitors, synthetic auxins, ALS inhibitors, ACCase inhibitors, and EPSPS inhibitors

Ten Herbicides: 1/10

Herbicide common name: 2,4-D

Listed in Ross and Lembi pages: 227-232

Representative trade name: Trimec

Family: phenoxy acid

Family features: often blended with related chemicals including the benzoic acid herbicide dicamba, often volatile and can cause downwind injury to sensitive crops, mainly foliage absorbed, formulated as water-soluble amines or emulsifiable esters which have higher volatility than amines

Mechanism of action: synthetic auxin, specific site unknown

Action details: auxin-type (IAA) herbicide causes cell wall plasticity

Plant symptoms: epinasty (malformed new growth)

Method of translocation: symplastic

Site of uptake: leaves

Selectivity: yes

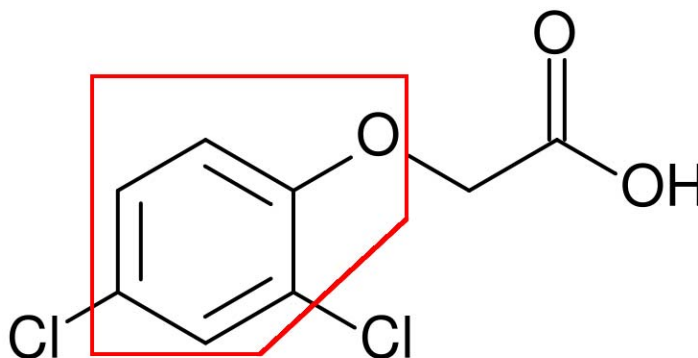
Plants affected: broadleaf

LD₅₀ acute oral rat: 639

Typical half-life in field, in days: 10

Major uses: cereals and other grass crops including pasture and turf, mostly sprayable

Molecular structure: highlighted in red is the phenoxy group



Ten Herbicides: 2/10

Herbicide common name: glyphosate

Listed in Ross and Lembi pages: 238-239

Representative trade name: Roundup

Family: glycine

Family features: crop plants have been developed with resistance to glyphosate, the only herbicide in this family

Mechanism of action: EPSPS inhibitor

Action details: inhibits enzyme 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase responsible for the shikimic acid pathway, resulting in depletion of the aromatic amino acids tryptophan, tyrosine, and phenylalanine needed for biosynthesis and growth.

Plant symptoms: cessation of growth, starting with buds, chlorosis, necrosis, 4-20 dys

Method of translocation: symplastic

Site of uptake: leaves

Selectivity: no

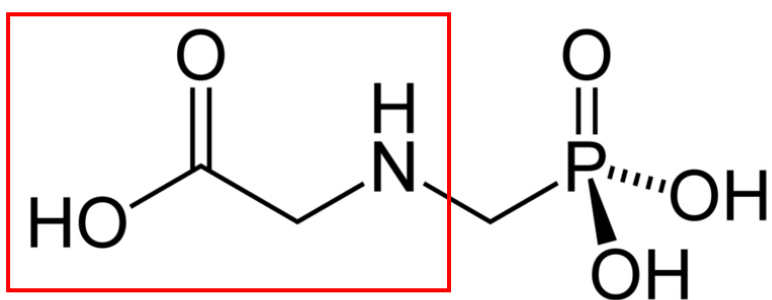
Plants affected: all

LD₅₀ acute oral rat: 5600

Typical half-life in field, in days: 47

Major uses: selective placement, spot treatment, and non-crop uses including control of perennial grasses

Molecular structure: highlighted in red is the glycine



Ten Herbicides: 3/10

Herbicide common name: metsulfuron

Listed in Ross and Lembi pages: 239-246

Representative trade name: Escort

Family: sulfonylurea

Family features: several herbicides with varying selectivities to grasses, sedges, and broadleaf weeds, active at very low doses, e.g., commonly 0.06 to 1.0 oz a.i./acre so can be prone to accidental contamination and tracking from treated areas

Mechanism of action: ALS inhibitor

Action details: inhibitors acetolactate synthase (ALS), key enzyme in the biosynthesis of branched-chain amino acids isoleucine, leucine, and valine

Plant symptoms: cessation of growth, discoloration, plant death, occurs slowly

Method of translocation: symplastic primarily

Site of uptake: leaves and roots

Selectivity: yes

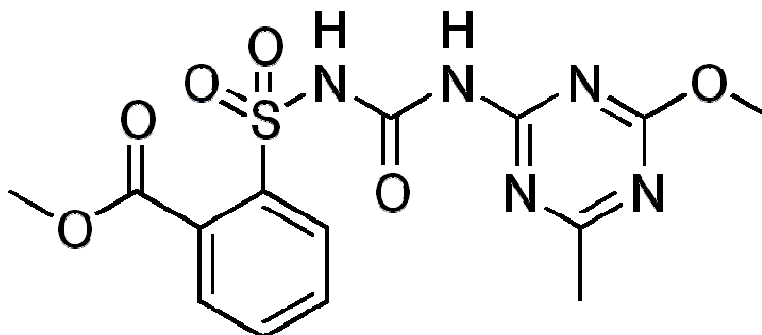
Plants affected: broadleaf

LD₅₀ acute oral rat: >5000

Typical half-life in field, in days: 30

Major uses: small grains, pastures, and turf

Molecular structure: from the sulfur to the right ring, these structures are common to the sulfonylurea herbicides, except metsulfuron has 3 Ns in the ring and other sulfonylurea herbicides have 2 Ns. The left ring is sometimes 5-carbon



Ten Herbicides: 4/10

Herbicide common name: imazapyr

Listed in Ross and Lembi pages: 246-248

Representative trade name: Arsenal

Family: imidazolinone

Family features: several herbicides with varying selectivities to grasses, sedges (e.g., imazaquin), and broadleaf weeds

Mechanism of action: ALS inhibitor

Action details: inhibitors acetolactate synthase (ALS), key enzyme in the biosynthesis of branched-chain amino acids isoleucine, leucine, and valine

Plant symptoms: cessation of growth, discoloration, plant death, occurs slowly

Method of translocation: symplastic primarily

Site of uptake: leaves primarily

Selectivity: yes

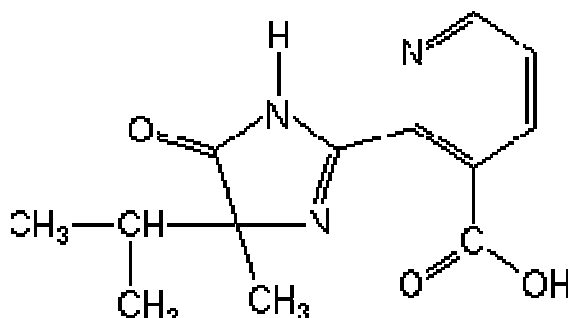
Plants affected: broadleaf and some grasses

LD₅₀ acute oral rat: >5000

Typical half-life in field, in days: 75

Major uses: total vegetation control

Molecular structure: the imidazole is a 5-ring with 2 Ns; it is called a heterocycle because it is a ring with at least one C and at least one atom not C. The ring at the far right is also a heterocycle and it is pyridine.



Ten Herbicides: 5/10

Herbicide common name: fluazifop-P

Listed in Ross and Lembi pages: 254-256

Representative trade name: Fusilade II

Family: aryloxyphenoxypropionate

Family features: grass-specific lipid biosynthesis inhibitors

Mechanism of action: ACCase inhibitor

Action details: acetyl CoA carboxylase inhibitor apparently blocks fatty acid synthesis in first step needed to build new membranes for cell growth

Plant symptoms: cessation of growth, discoloration

Method of translocation: symplastic

Site of uptake: leaves

Selectivity: yes

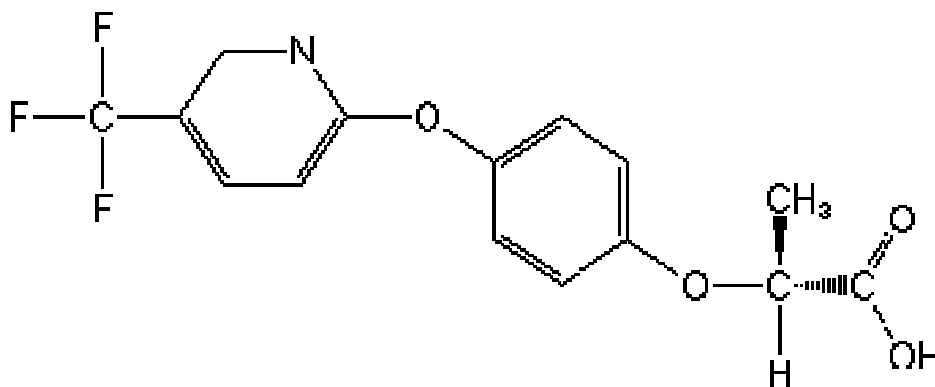
Plants affected: grasses

LD₅₀ acute oral rat: 2721

Typical half-life in field, in days: 15

Major uses: control grasses in field crops

Molecular structure: everything to the right of the first O is aryloxyphenoxypropionate



Ten Herbicides: 6/10

Herbicide common name: MSMA

Listed in Ross and Lembi pages: 258-259

Representative trade name: MSMA 6

Family: organic arsenical

Family features: concern over arsenic fate

Mechanism of action: unknown

Action details: rapid desiccation indicates cell membrane destruction

Plant symptoms: cessation of growth, chlorosis, and necrosis

Method of translocation: symplastic and apoplastic (from foliage)

Site of uptake: leaves

Selectivity: yes

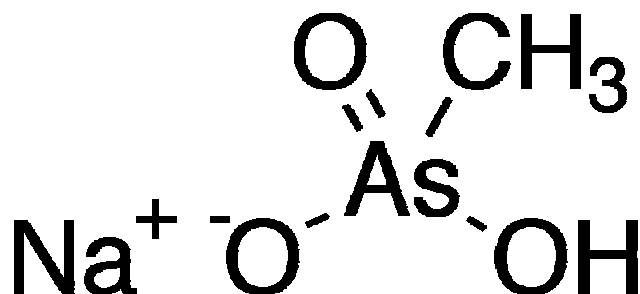
Plants affected: grasses

LD₅₀ acute oral rat: 2833

Typical half-life in field, in days: 180

Major uses: cotton, turf

Molecular structure: it is also called monosodium methane arsenate



Ten Herbicides: 7/10

Herbicide common name: atrazine

Listed in Ross and Lembi pages: 260-256

Representative trade name: Aatrex

Family: triazine

Family features: foliage and root absorbed; concerns over groundwater carryover

Mechanism of action: photosystem II inhibitor

Action details: binds on D1 protein in chloroplast thylakoid membranes, blocking electron transport

Plant symptoms: chlorosis, tip necrosis, from older growth to younger growth, sometimes growth stimulation

Method of translocation: apoplastic

Site of uptake: leaves and roots

Selectivity: yes

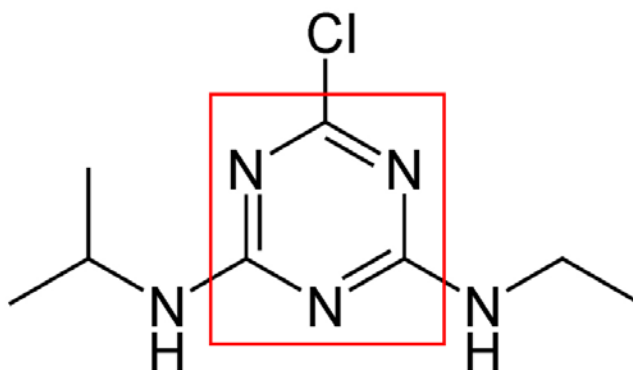
Plants affected: broadleaf and some grasses

LD₅₀ acute oral rat: 3090

Typical half-life in field, in days: 60

Major uses: soil applied and postemergence to kill broadleaf weeds

Molecular structure: the triazine ring is the 3-N ring



Ten Herbicides: 8/10

Herbicide common name: paraquat

Listed in Ross and Lembi pages: 272-273

Representative trade name: Gramoxone

Family: bipyridilium

Family features: contact herbicides destroying membranes, paraquat is highly toxic to humans; another herbicide, diquat, is used in aquatic weed control

Mechanism of action: photosystem I electron diverter

Action details: hydroxyl radicals destroy membrane fatty acids in a chain reaction resulting in cytoplasm leakage through cell membranes

Plant symptoms: rapid chlorosis, desiccation

Method of translocation: not translocated

Site of uptake: leaves

Selectivity: no

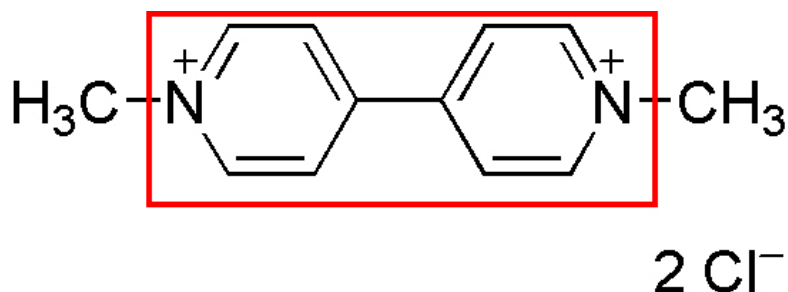
Plants affected: all

LD₅₀ acute oral rat: 112

Typical half-life in field, in days: 1000 (but tightly bound)

Major uses: directed spray or non-crop use

Molecular structure: the red rectangle outlines the bipyridine (2 pyridine rings)



Ten Herbicides: 9/10

Herbicide common name: oxadiazon

Listed in Ross and Lembi pages: 275-276

Representative trade name: Ronstar

Family: oxadiazole

Family features: contact herbicides destroying membranes

Mechanism of action: protox inhibitor

Action details: protoporphyrinogen oxidase leads to accumulation of PPIX a chlorophyll precursor, light absorption, a lipid radical, and a chain reaction of lipid peroxidation

Plant symptoms: discoloration, bronzing

Method of translocation: not translocated

Site of uptake: leaves primarily (but soil applied)

Selectivity: slightly

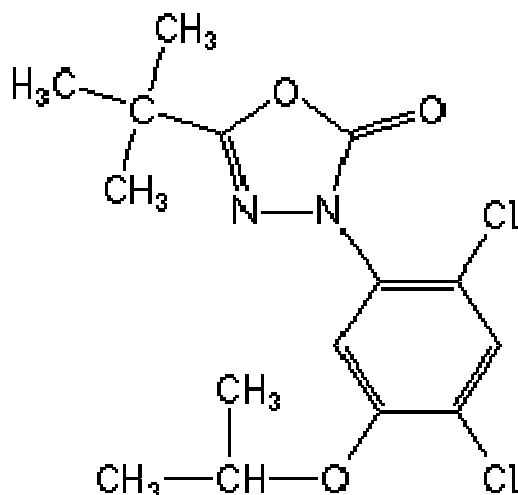
Plants affected: grasses and broadleaf weeds

LD₅₀ acute oral rat: >5000

Typical half-life in field, in days: 60

Major uses: preemergence

Molecular structure:



Ten Herbicides: 10/10

Herbicide common name: pendimethalin

Listed in Ross and Lembi pages: 279-283

Representative trade name: Pre-M

Family: dinitroaniline

Family features: preemergence herbicides, often with considerable staining potential

Mechanism of action: microtubule / spindle apparatus (root) inhibitor

Action details: herbicide-tubulin complex leads to loss of microtubules, absence of the spindle apparatus, preventing alignment and separation of chromosomes

Plant symptoms: swelling of root tips

Method of translocation: translocation is not important

Site of uptake: leaves and roots (but primarily soil applied)

Selectivity: slightly

Plants affected: grass seedlings

LD₅₀ acute oral rat: >5000

Typical half-life in field, in days: 44

Major uses: preemergence and early postemergence

Molecular structure: outlined in red is the dinitroaniline structure common to all dinitroaniline herbicides

