MOBILE PHOTOSYNTHESIS INHIBITORS

Group	Site of Action	Family	Product
5	Photosynthesis inhibition at PSII - site A (73)	Triazine Triazinone Uracil	Atrazine Sencor Hyvar X
7	Photosynthesis inhibition at PSII - site A (28) - different binding	Urea	Lorox/ Linex Spike

MOBILE PHOTOSYNTHESIS INHIBITORS

ACTION	**-**	**Bind to sites within chloroplasts and stop carbohydrate production**
INJURY	**-**	**Symptoms occur after leaves emerge. Chlorosis of older leaf margins or tips initially. Interveinal chlorosis in broadleaf plants. Tissue will turn brown and die.**

NON-MOBILE PHOTOSYNTHESIS INHIBITORS

Group	Site of Action	Family	Product
6	Photosynthesis inhibition at PSII - site B (4)	Nitrile	Buctril
		Benzothia -diazole	Basagran

NON-MOBILE PHOTOSYNTHESIS INHIBITORS

ACTION	**-**	**Bind to sites within chloroplasts and stop carbohydrate production.**
INJURY	**-**	**Postemergence activity only. Leaves turn yellow or bronze and then turn brown and die. Symptoms like that from cell membrane disrupters.**

GLUTAMINE SYNTHETASE INHIBITOR

Group	Site of Action	Family	Product
10	Glutamine synthetase inhibition (3)	None	Ignite 280 Liberty 280 Rely 280

GLUTAMINE SYNTHETASE INHIBITOR

ACTION	-	Inhibits glutamine synthetase. Accumulation of ammonia destroys cells and directly inhibits photosystem I and II reactions.
INJURY	-	Chlorosis and wilting usually within 3-5 days, followed by necrosis in 1-2 weeks.

CELL MEMBRANE DISRUPTERS

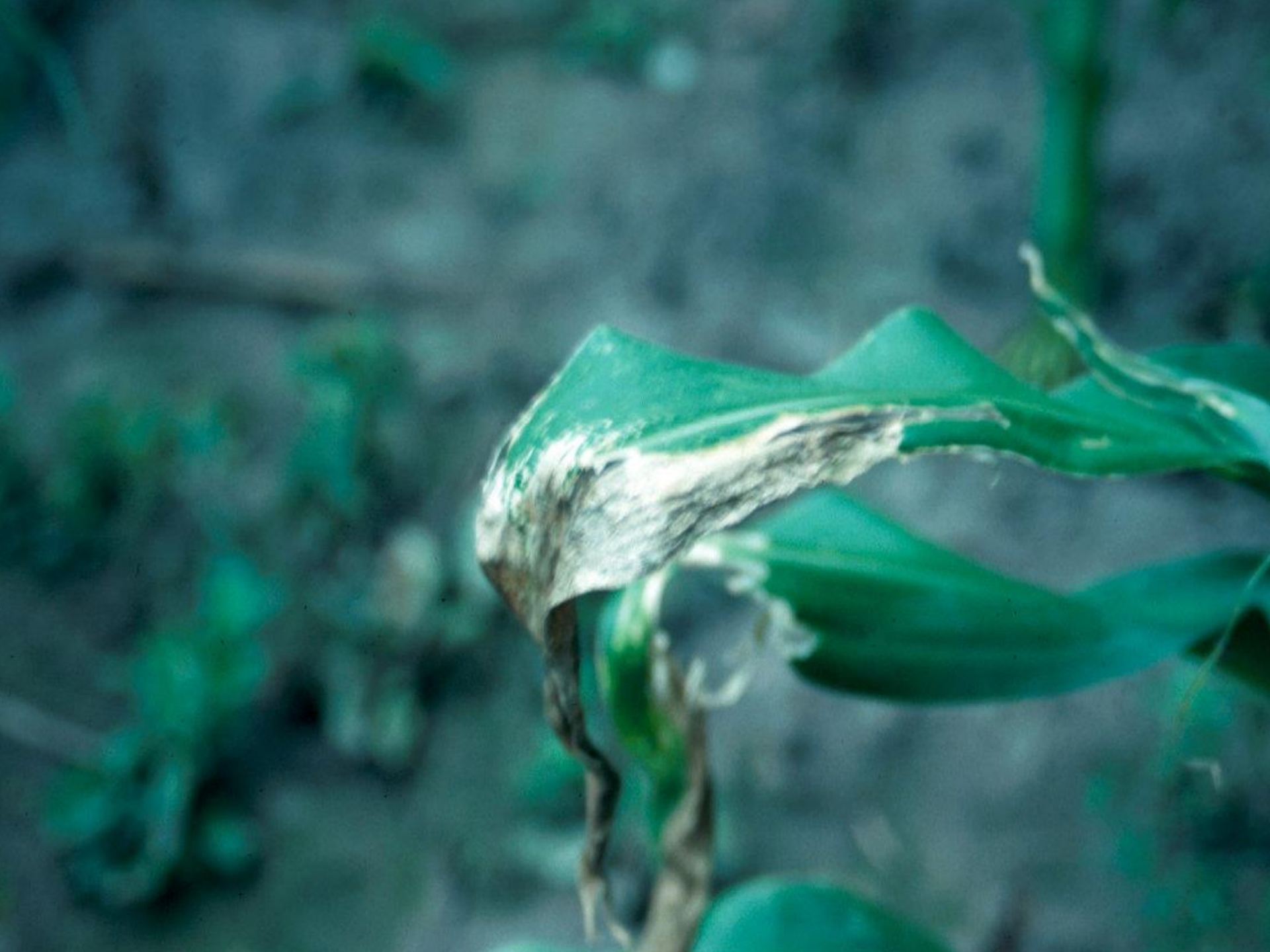
Group	Site of Action	Family	Product
14	PPO inhibition (13)	Diphenyl-ether	Reflex Cobra
		N-phenyl-phthalimide	Resource Valor SX
		Triazolinone	Aim
		Pyrimidine-dione	Sharpen aka Kixor

CELL MEMBRANE DISRUPTERS

Group	Site of Action	Family	Product
22	Photosystem I electron diversion (32)	Bypyridilium	Gramoxone Inteon

CELL MEMBRANE DISRUPTERS

ACTION	**-**	**Activated by sun to form oxygen compounds which rupture cell membranes.**
INJURY	**-**	**With Gramoxone Inteon, a water soaked appearance followed by necrosis. With others leaves turn yellow, then bronze/brown and die.**



SEEDLING SHOOT INHIBITORS

Group	Site of Action	Family	Product
15	Long-chain fatty acid inhibition (5)	Chloroacet-amide	Harness/ Surpass Outlook Dual II Mag
8	Lipid synthesis inhibition (not ACCase) (10)	Thiocarb-amate	Eptam

SEEDLING SHOOT INHIBITORS

ACTION	- Affect multiple sites, interfere with fatty acid, lipid, and protein synthesis.
INJURY	- Highly susceptible weeds do not emerge. Grasses leaf out underground, leaves do not unfurl. Broadleaf plants have crinkled or puckered leaves and/or shortened mid-vein.

PIGMENT INHIBITORS

Group	Site of Action	Family	Product
27	4-HPPD inhibition (2)	Triketone	Callisto Laudis
		Pyrazole	Impact
		Isoxazole	Balance
13	Diterpene biosynthesis inhibitor (1)	Isoxazolid-inone	Command

PIGMENT INHIBITORS

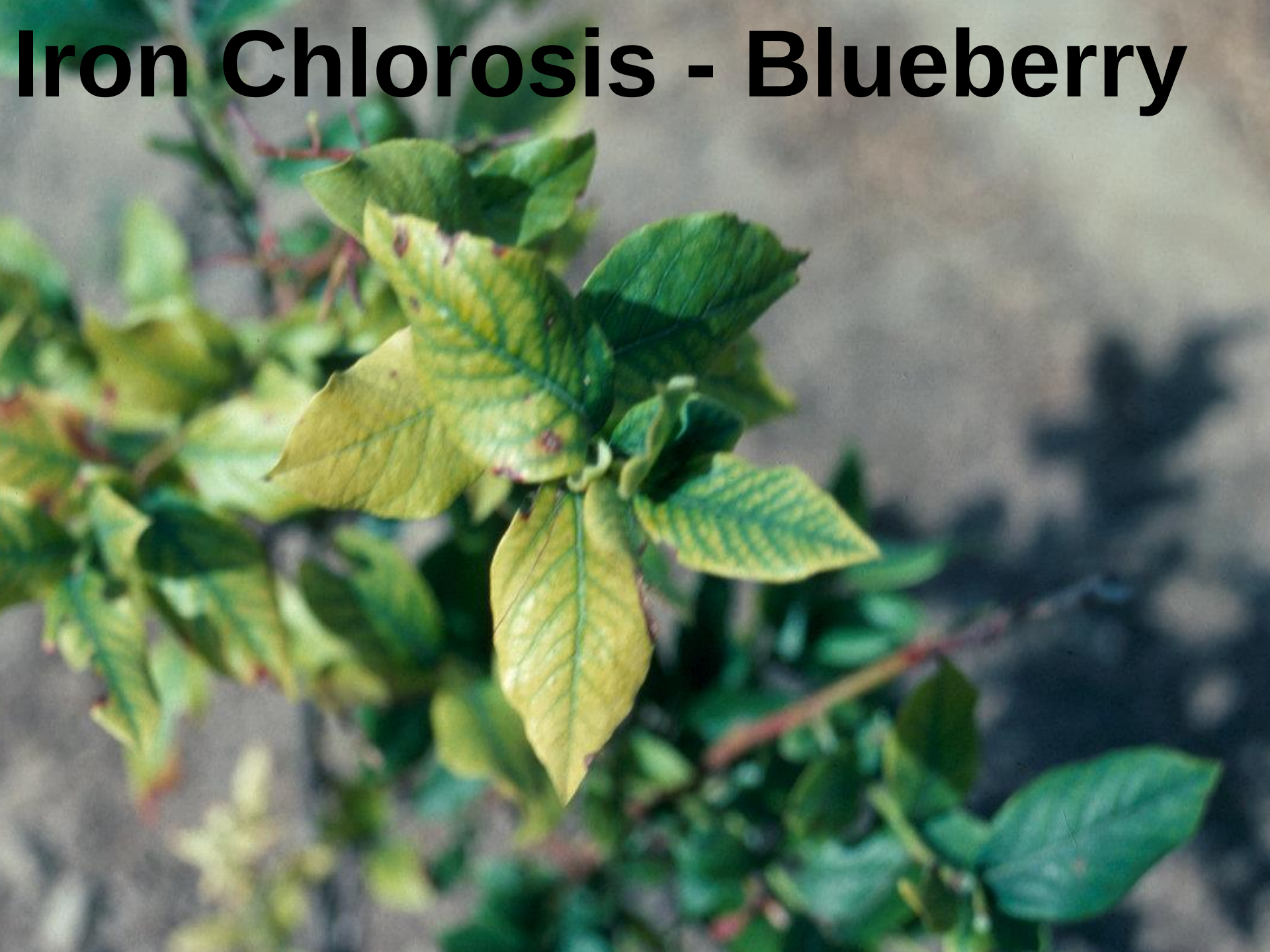
ACTION	-	Inhibit 4-HPPD which affects carotenoid (photosynthetic pigments) synthesis.
INJURY	-	Plants appear white or bleached, often becoming translucent at the leaf tips.

OTHER CAUSES OF CROP INJURY

- Adverse weather conditions
- Diseases
- Insects
- Nutrient deficiencies/excesses
- Air pollution

Nitrogen Deficiency - Corn

Iron Chlorosis - Blueberry



TIME OF APPLICATION

Early Preplant - Surface applied before crop is planted

Incorporated - Applied before planting and mixed with soil

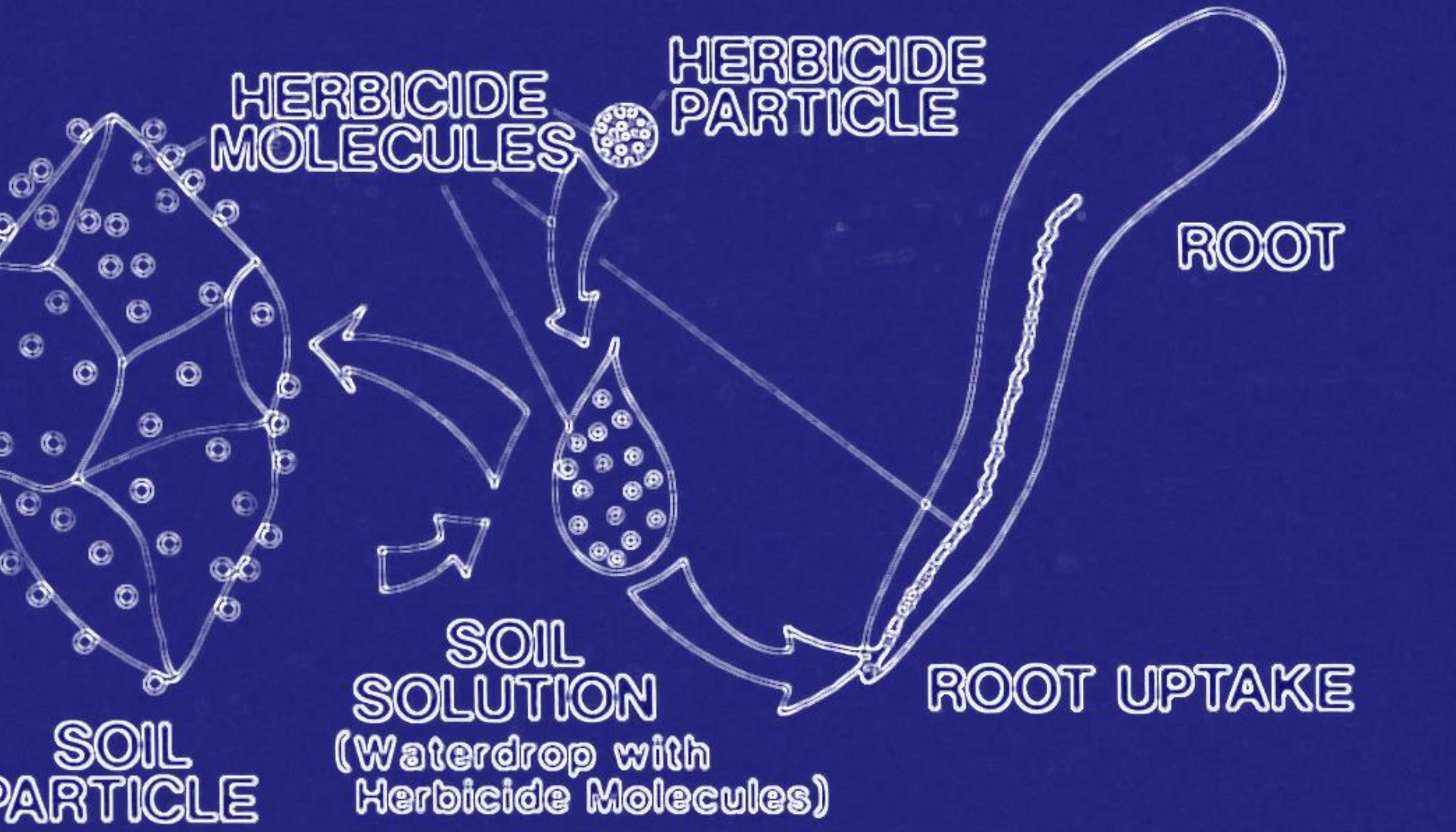
Preemergence - Applied to soil surface before crop and weeds emerge

Postemergence - Applied after crop and weeds emerge

Preplant Incorporated

Preemergence

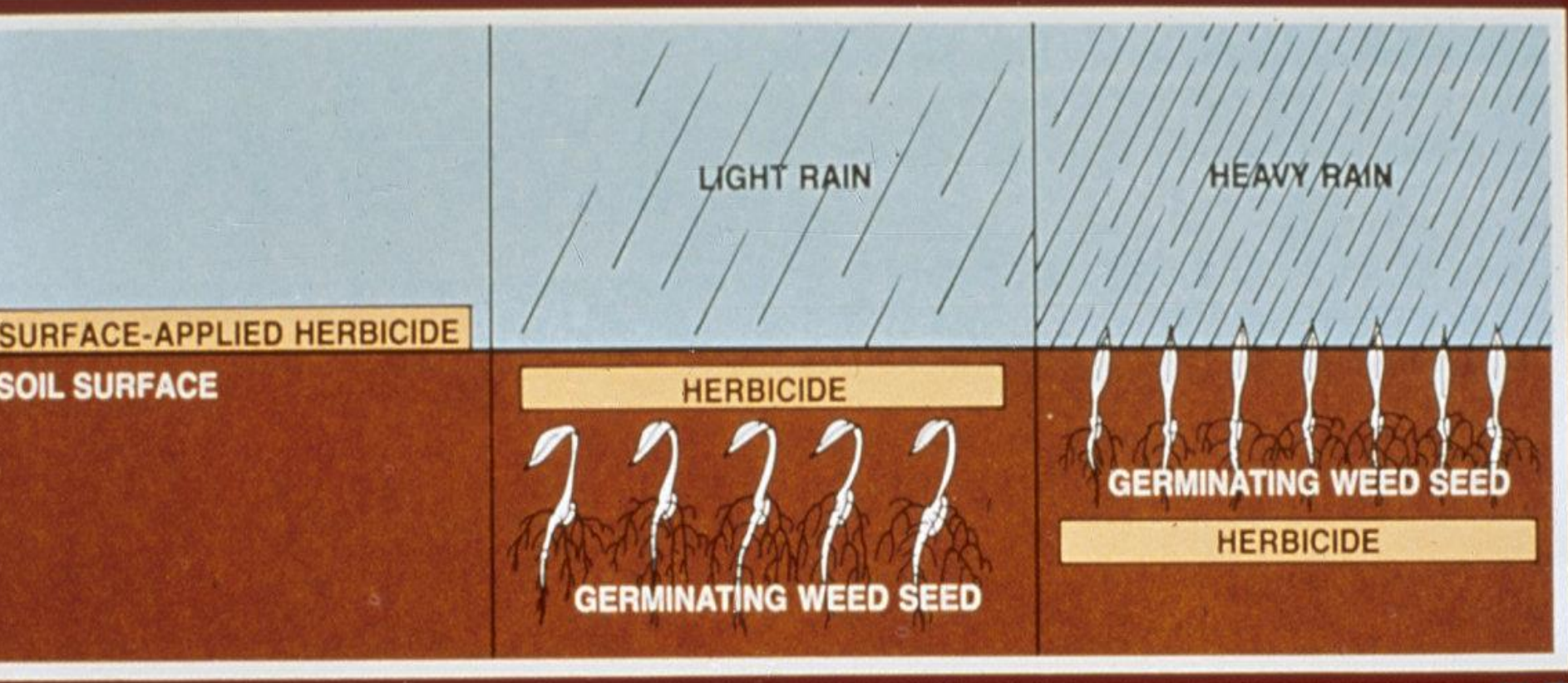
L MOISTURE/HERBICIDE RELATIONSHIP



PREEMERGENCE PERFORMANCE

- Amount of rainfall or irrigation

EFFECTS OF RAIN



PREEMERGENCE PERFORMANCE

- Amount of rainfall or irrigation
- Herbicide solubility

SOLUBILITY AND SOIL SORPTION

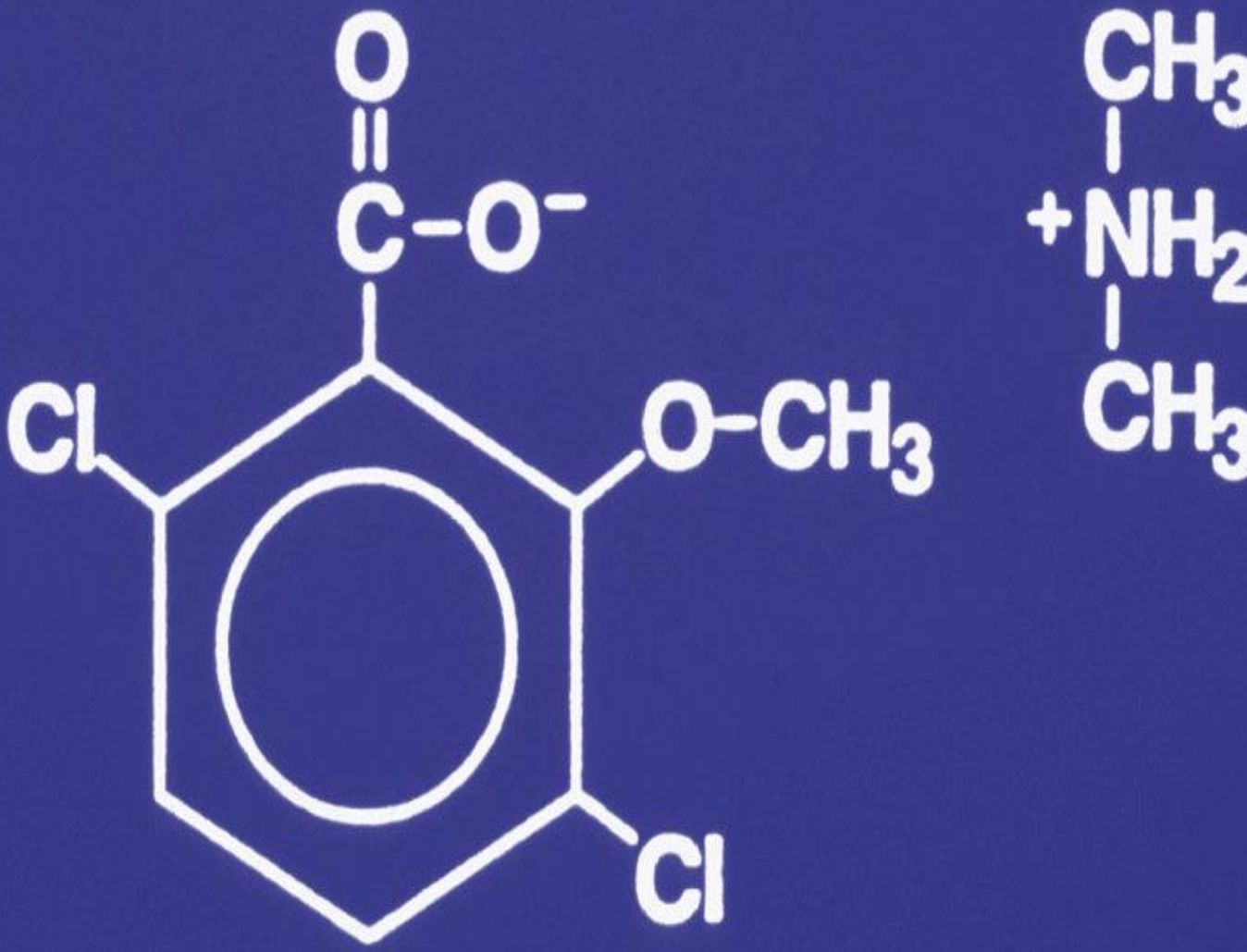
Herbicide	Solubilty (ppm)	Sorption (koc)
Prowl	<1	17,200
Princep	3.5	130
Atrazine	33	100
Dual II Mag	488	200

PREEMERGENCE PERFORMANCE

- Amount of rainfall or irrigation
- Herbicide solubility
- Herbicide adsorbed on soil
  - Herbicide chemistry

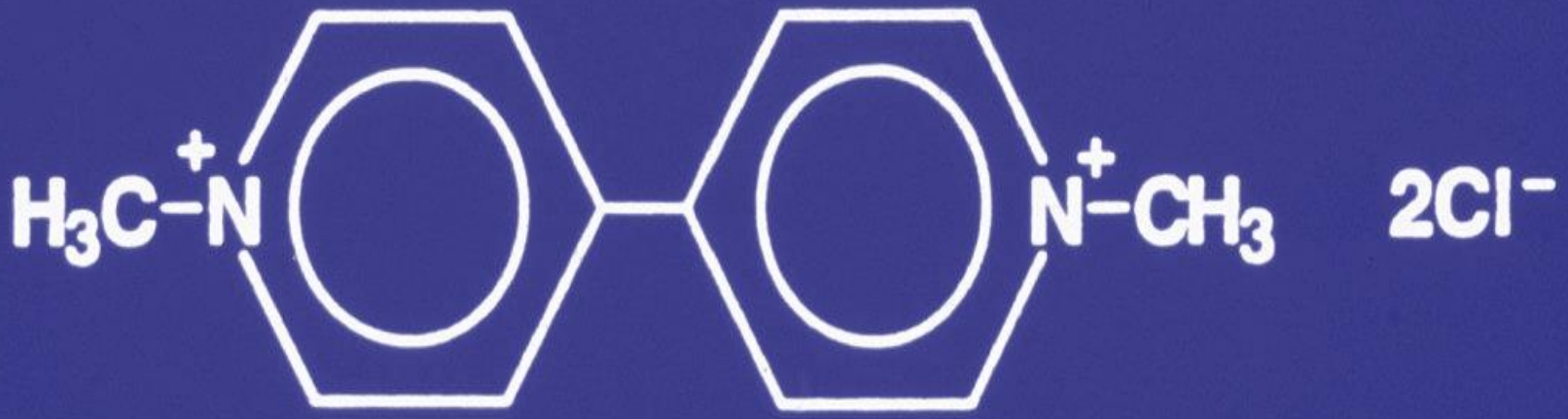
Dicamba dimethylamine salt

Banvel or Clarity



Gramoxone

Paraquat dichloride salt



PREEMERGENCE PERFORMANCE

- Amount of rainfall or irrigation
- Herbicide solubility
- Herbicide adsorbed on soil
  - Herbicide chemistry
  - Soil texture
  - Organic matter

EXCHANGE CAPACITIES OF SOIL CONSTITUENTS

Soil Constituent	CEC
Sand	2-6
Silt	10-20
Kaolinite clay	2-15
Illite clay	10-40
Montmorillonite clay	80-150
Organic matter/humus	200-400

LB OF DIMETRIC DF/ACRE

	Organic Matter		
Soil Texture	**< 2%**	**2 to 4%**	**> 4%**
Coarse	**Do Not Use**	**.5**	**.66**
Medium	**.5 - .66**	**.66 - .83**	**.83 - 1**
Fine	**.66 - .83**	**.83 - 1**	**1 – 1.17**

FACTORS AFFECTING POST PERFORMANCE

- Timing
- Application
- Environment

TIMING OF POST HERBICIDES

Annuals

Summer - Seedlings in spring or summer

Summer Annuals

TIMING OF POST HERBICIDES

Annuals

Summer - **Seedlings in spring or summer**

Winter - **Seedlings or rosettes in fall or early spring**

-

Winter Annual

TIMING OF POST HERBICIDES

Annuals

- **Summer** - **Seedlings in spring or summer**
- **Winter** - **Seedlings or rosettes in fall or early spring**

Biennials - **Rosettes or other growth in fall or early spring**

Biennial - Bull Thistle

TIMING OF POST HERBICIDES

Annuals

- **Summer - Seedlings in spring or summer**
- **Winter - Seedlings or rosettes in fall or early spring**

Biennials - Rosettes or other growth in fall or early spring

Perennials - Vigorous fall growth or bud stage in spring or summer

Perennial - Canada Thistle

APPLICATION FACTORS

- Spray volume
- Spray pressure
- Spray adjuvants - additives that aid or modify the action of the active ingredient(s)

ENVIRONMENTAL FACTORS

- Light
- Temperature
- Relative humidity
- Wind
- Rain

PROBLEMS WITH HERBICIDE USE

- Herbicide resistant weeds

HERBICIDE RESISTANT WEEDS SUMMARY 11/25/17

Herbicide Group	WSSA Group	Example Herbicide	Total
ALS inhibitor	2	Steadfast Q	159
Triazine	5	Atrazine	73
ACCase inhibitor	1	Fusilade	48
Glycine	9	Roundup	38
Synthetic Auxin	4	2,4-D	36
Bipyridilium	22	Gramoxone	32
Ureas and Amide	7	Lorox	28
PPO inhibitors	14	Sharpen	13

HERBICIDE RESISTANT WEEDS SUMMARY 11/25/17

Herbicide Group	WSSA Group	Example Herbicide	Total
Dinitroaniline, etc.	3	Prowl	12
Thiocarbamate, etc.	8	Eptam	10
Chloroacetamide,etc.	15	Dual II Mag	5
Nitriles and others	6	Buctril	4
Glutamine syn. inh.	10	Liberty 280	3
HPPD inhibitors	27	Callisto	2
Others	-	-	22
Total Herbicide Resistant Biotypes			485

How Does Herbicide Resistance Develop?

- ✓ Herbicides do not “create” resistance
- ✓ Genetic mutation (rare)
- ✓ Individual plants naturally resistant are
- ✓ present in very low numbers
- ✓ Herbicides select for those resistant individuals

Two things required for glyphosate resistant weeds to develop…

1. Must be resistant biotypes in the field
2. Must be selection pressure
   a) Which is directly correlated with how frequently glyphosate was applied

Detection of Resistant Weeds

- Early, unnoticed resistance
  - Handful of weeds survive, nobody notices
- Apparent resistance
  - About 30% weed control failure of particular species before it is noticed
- Scout fields to identify escapes

Weed Resistance Management

- Cultural Tactics
  - Crop Rotation
- Mechanical Tactics
  - Tillage prior to planting to kill emerged weeds
- Chemical Tactics
  - Use herbicides with little soil activity and/or short residual
  - Use tank mixtures or sequential herbicide treatments with different sites of action in each crop
  - Tank mix different herbicides with different site of action and activity on the same target weed

PROBLEMS WITH HERBICIDE USE

- Herbicide resistant weeds
- Off site movement

Spray Drift

How can off site movement happen?

- **Physical drift: pesticide droplets or particles moving outside area treated**
  - **Scale of tens of yards**
  - **Function of sprayer/weather**

Adopted from Jason Deveau, OMAFRA

How can off site movement happen?

- **Volatility: pesticide vapors moving outside the area being treated**
  - **Scale of miles**
  - **Function of chemistry/weather**

Adopted from Jason Deveau, OMAFRA

How can off site movement happen?

- **Temperature inversion: pesticide droplets or particles moving outside area treated**
  - **Air temperature at ground is lower than air above it**
  - **Wind speed under 3 mph**
  - **Small droplets (fog) become suspended and transport horizontally for miles**

Adopted from Jason Deveau, OMAFRA

PROBLEMS WITH HERBICIDE USE

- Herbicide resistant weeds
- Off site movement
- Crop injury