Chemical Drift in Potato Crops

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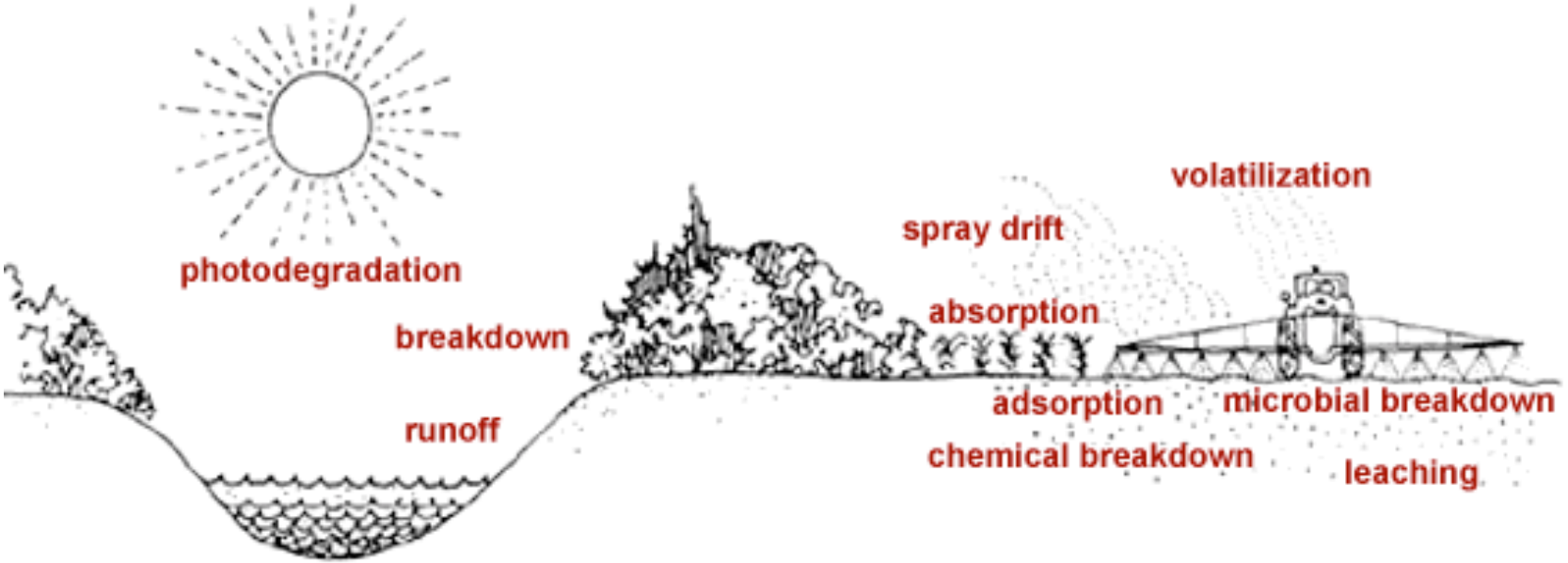
Topics

- Herbicide off-target principles
- Herbicides injury in potato

Introduction

- Potatoes are sensitive to many herbicides
  - Evidence: limited herbicide options for potato postemergence.
  - Chlorosis, necrosis, and growth reduction.
  - Tubers are easily misshaped and malformed.

Fate of herbicides



http://www.agf.gov.bc.ca/pesticides/c_2.htm

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Exposure to herbicides

- Soil Carryover
- Particle drift (including inversions)
- Contamination of spraying equipment
- Volatilization
- Misapplication
- Seed carryover

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Soil carryover

- Follow label.
- When in doubt, follow the label.
- Don’t call me and ask for permission.

Drift – particle size

Influence of droplet size on potential distance of drift

Droplet diameter (microns)	Type of droplet	Time required to fall 10 feet	Lateral distance droplets travel in falling 10 feet in a 3 mph wind
5	Fog	66 minutes	3 miles
20	Very fine spray	4.2 minutes	1,100 feet
100	Fine spray	10 seconds	44 feet
240	Medium spray	6 seconds	28 feet
400	Coarse spray	2 seconds	8.5 feet
1,000	Fine rain	1 second	4.7 feet

Coverage of droplets

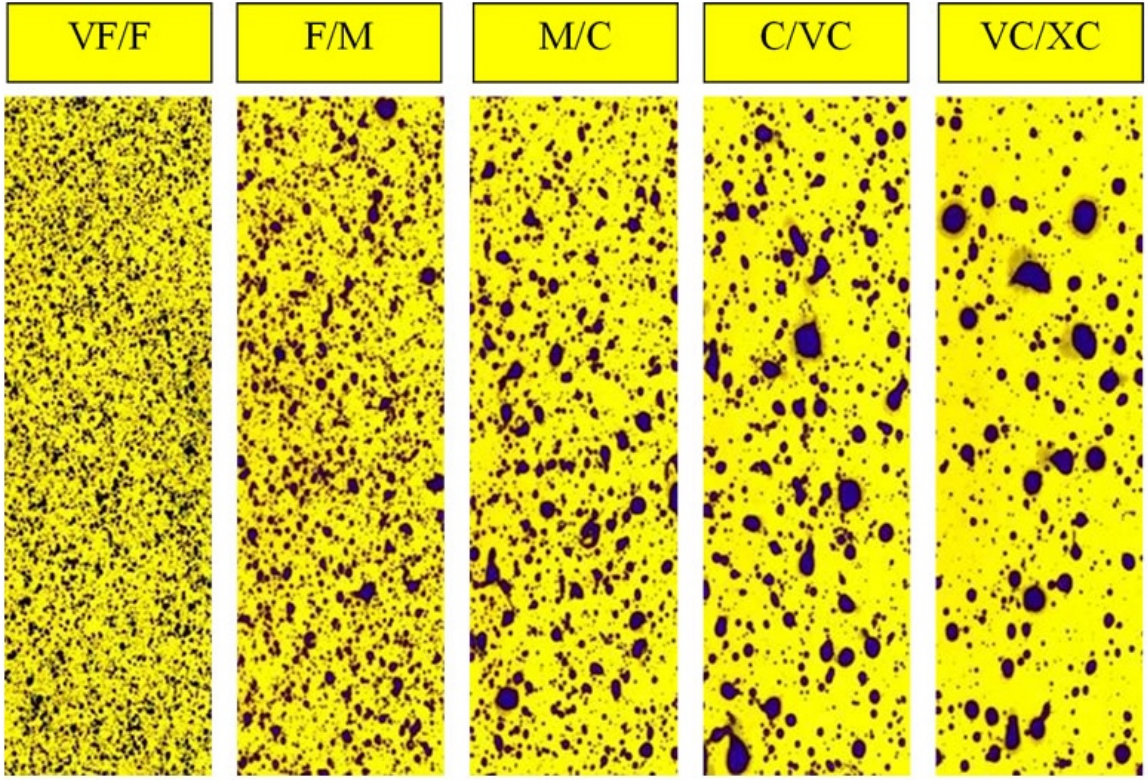

Image courtesey of Tom Wolf, Agriculture and Agri-Food Canada, Research Centre

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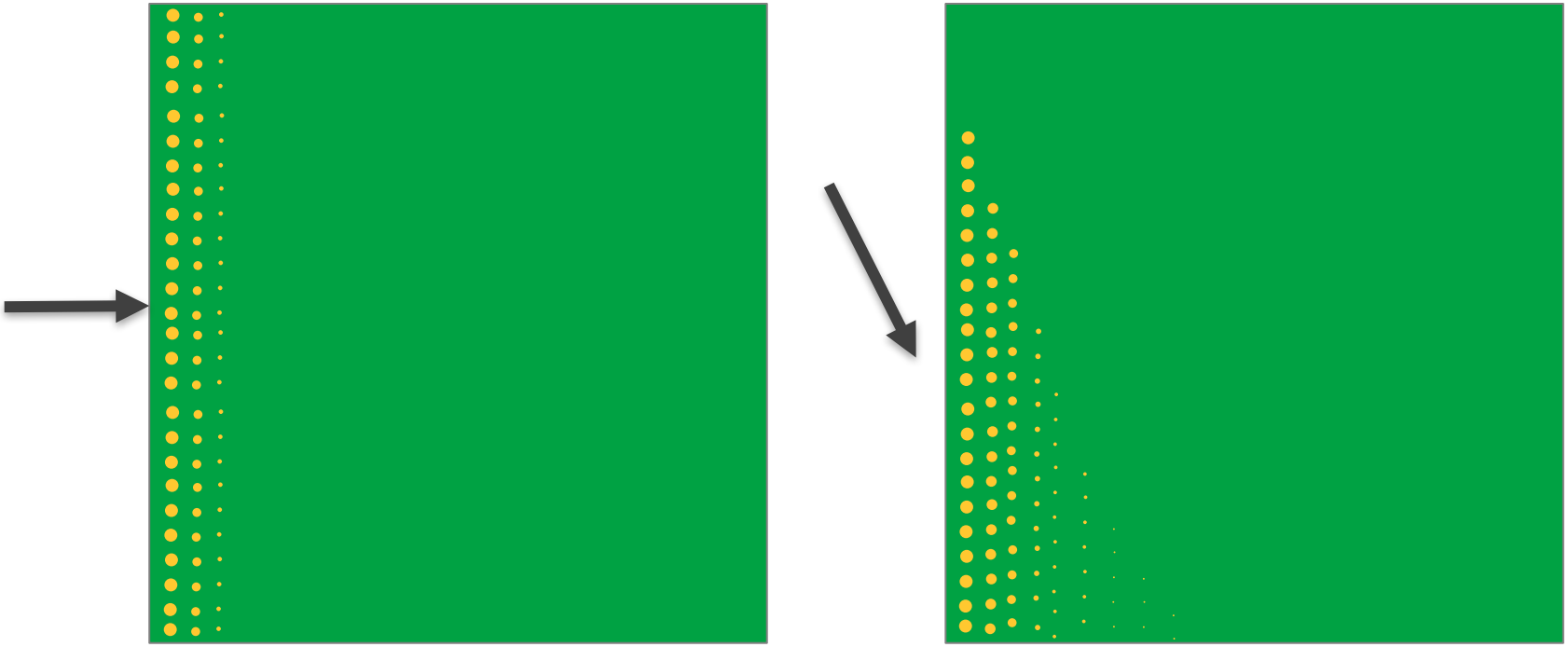
Drift

- Movement of particles outside of target area.
  - Crop damage
  - Economic loss
  - Prohibited residues

Field pattern



How to reduce drift

- Lower nozzle height
- Reduce pressure
- Don’t spray in high winds
- Use larger droplets when appropriate
- Follow manufacturer guidelines

Tank contamination

Tank contamination

- Tank Contamination
  - Soybean injury can occur from 0.01% of 8 fl oz/A dicamba
- Incomplete clean-out
  - 0.01% = 6.4 oz left after 16 fl oz/A Clarity in 500 gallon spray tank
  - 0.1% = 2 quarts left after 16 fl oz/A Clarity in 500 gallon spray tank
- Contaminated jugs or equipment
  - 0.01% = 0.05 oz or 1.5 mL Clarity in 500-gallon load

Tank residue case study

Water source	Dicamba (ppb)	Use rate (%)
Spray tank	945	0.024%
Spray tank after overnight	822	0.021%
Spray boom	24,800	0.63%

Based on 1 pt/A Clarity applied in 15 gal/A.
Spray tank cleaned out prior to test.

(Boerboom, 2004)

Sprayer cleanout

- Drain tank, rise thoroughly
- Fill with clean water, add cleaning solution
- Let sit for 8 hours
- Spray solution through nozzles
- Clean nozzles, screens, and filter. Rinse sprayer.

Herbicide volatility

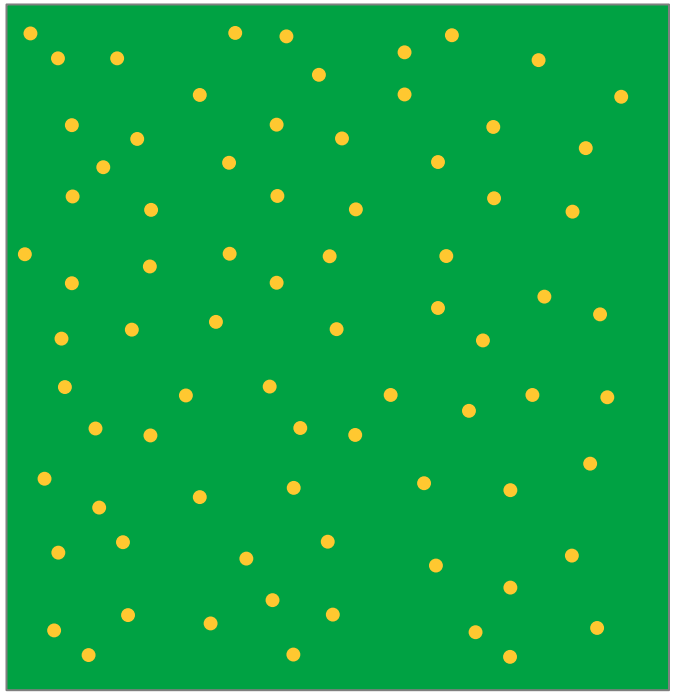
- Herbicide volatility is the result of movement after application when the herbicide converts to a gas and moves from the application site.
- Volatility can occur when spray solution settles on-site and then changes to a vapor and moves off-site.
- Herbicide vapor can be carried off-site by wind.
- Volatility is a characteristic of the formulation of the herbicide and, in some cases, the active ingredient.

Volatilization

Misapplication

Seed carryover

- Herbicides can carryover in seed.
- Erratic pattern of emergence.
- Plants are malformed.



What to look for

Drift/Carryover

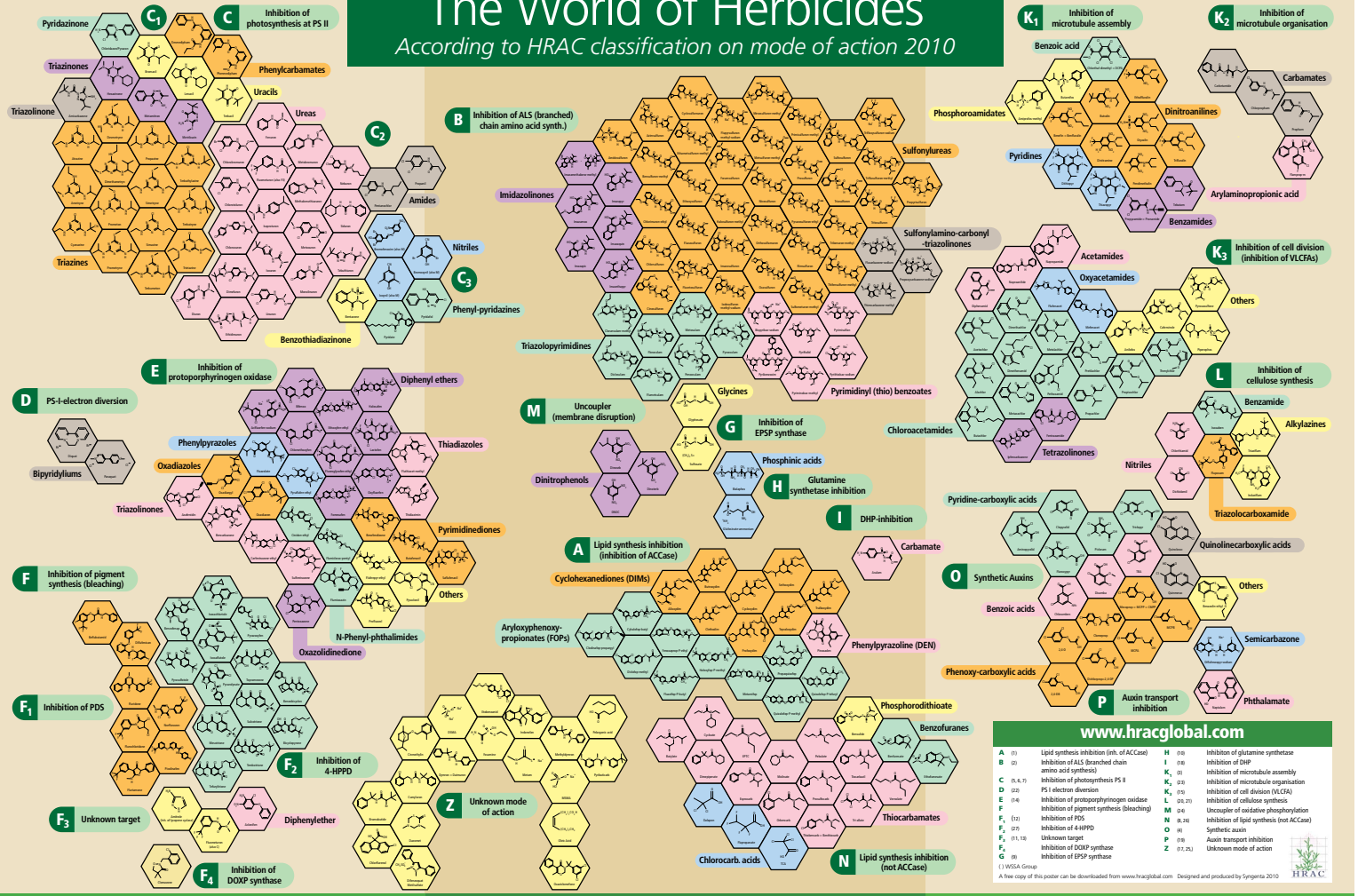
- Epinasty, wrinkled leaves in the foliage
- Tuber malformations
- Lab testing verifying dicamba and/or glyphosate

Seed with Residues

- Malformed seed
- Delayed emergence
- Twisting, bending of the foliage
- Lab testing verifying dicamba and/or glyphosate

The World of Herbicides

According to HRAC classification on mode of action 2010



www.hracglobal.com

A (1)	Lipid synthesis inhibition (inh. of ACCase)	H (10)	Inhibition of glutamine synthetase
B (2)	Inhibition of ALS (branched chain amino acid synthesis)	I (18)	Inhibition of DHP
C (5, 6, 7)	Inhibition of photosynthesis PS II	K_1 (3)	Inhibition of microtubule assembly
D (22)	PS I electron diversion	K_2 (23)	Inhibition of microtubule organisation
E (14)	Inhibition of protoporphyrinogen oxidase	K_3 (15)	Inhibition of cell division (VLCFA)
F	Inhibition of pigment synthesis (bleaching)	L (20, 21)	Inhibition of cellulose synthesis
F_1 (12)	Inhibition of PDS	M (24)	Uncoupler of oxidative phosphorylation
F_2 (27)	Inhibition of 4-HPPD	N (8, 26)	Inhibition of lipid synthesis (not ACCase)
F_3 (11, 13)	Unknown target	O (4)	Synthetic auxin
F_4	Inhibition of DOXP synthase	P (19)	Auxin transport inhibition
G (9)	Inhibition of EPSP synthase	Z (17, 25,)	Unknown mode of action

( ) WSSA Group

A free copy of this poster can be downloaded from www.hracglobal.com Designed and produced by Syngenta 2010

HRAC

HERBICIDES AFFECTING: Light Processes | Cell Metabolism | Growth/Cell Division

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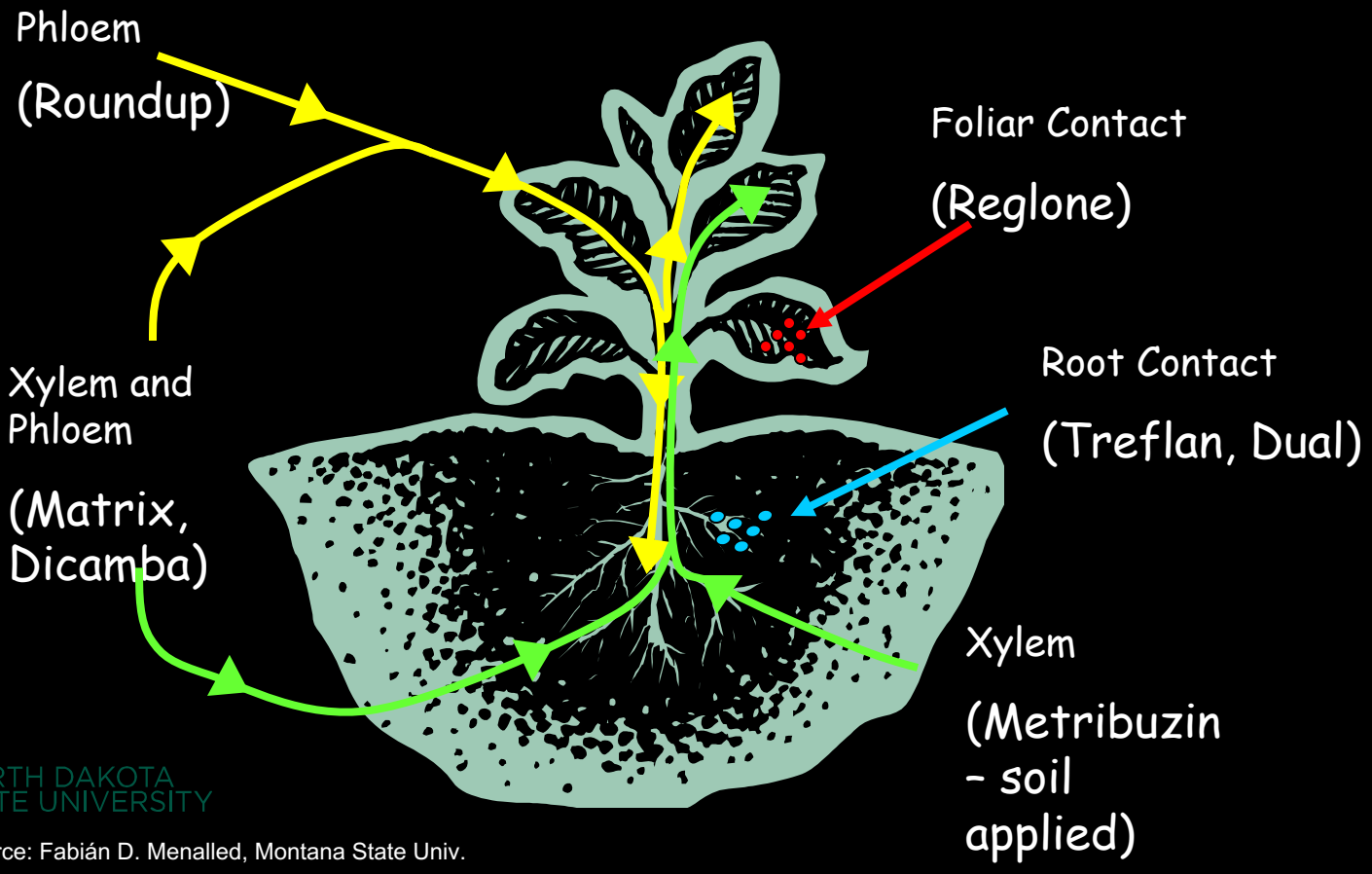
Site of Absorption and Translocation



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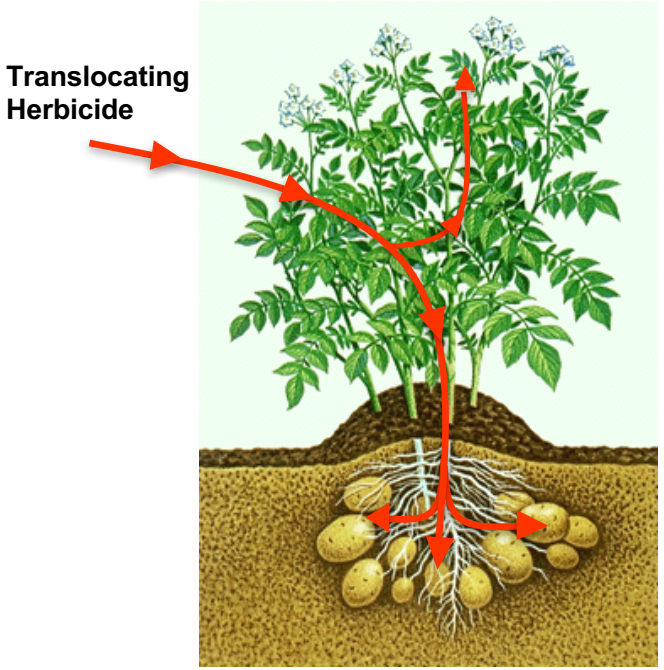
Source: Fabián D. Menalled, Montana State Univ.

Postemergence herbicides

1. Contact and xylem mobile herbicides
   - Disrupts foliage growth
   - Can stress plant = malformation of tubers
2. Phloem mobile herbicides
   - Disrupts foliage and tuber growth
   - Residues in tubers

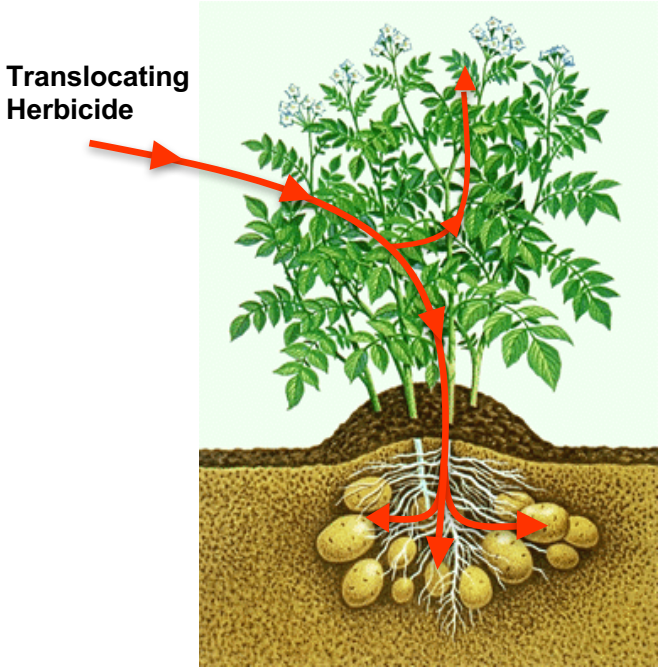
Herbicide movement

- Herbicides that translocate will move to tubers and residues can accumulate in tubers causing problems the following planting season.



Herbicide movement

- ALS inhibitors (Group 2)
- Growth regulators (Group 4)
- EPSP synthase inhibitor (Group 9)



ALS-inhibitor herbicides: Group 2

- Sulfonylureas (SU)
  - Harmony* (thifensulfuron-methyl), Accent (nicosulfuron), Express FX* (tribenuron)
- Imidazolinone (Imi)
  - Odyssey* (imazamox), Pursuit* (imazethapyr), Arsenal* (imazapyr)

*and other labeled herbicides

Sulfonylureas effect on foliage

- Potato leaves turn yellow.
- Plant growth is stunted.
- Leaves may wilt and roll.
- At higher does leaves and stems may become reddish purple.

Jed Colquhoun, University of Wisconsin, Bugwood.org

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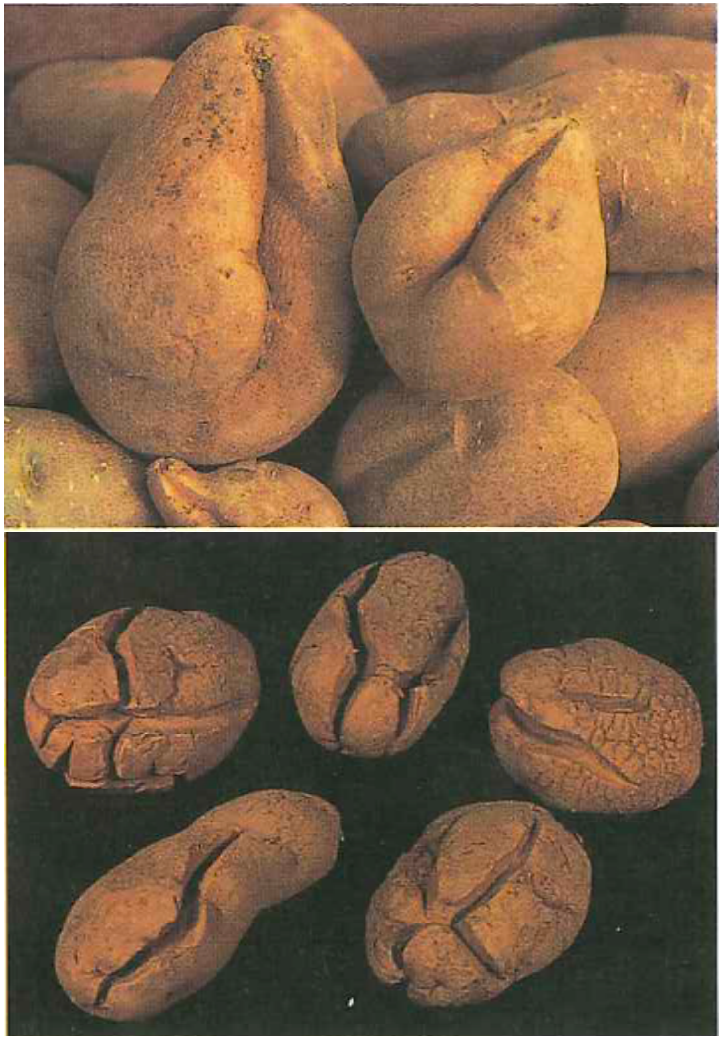
Sulfonylureas effect on tubers

- Smaller tubers
- Shallow to deep longitudinal cracks
- Knobs
- Banana, pear or folded shapes
- High doses = popcorn-shaped tubers or chains of tubers



Eberlein et al., 1997

Imidazolinones effect on foliage

- Yellowing of new growth (like SUs).
- Leaflets elongate and are wrinkled and can cup upward
- Leaflet tips develop a boat shape.

Jed Colquhoun, University of Wisconsin, Bugwood.org

Imidazolinones effect on foliage

- Yellowing of new growth (like SUs).
- Leaflets elongate and are wrinkled and can cup upward
- Leaflet tips develop a boat shape.

Imidazolinones effect on roots

- Pruned roots
- Short, slender lateral roots (bottle brushed)

Imidazolinones effect on tubers

- Smaller tubers
- Shallow to deep longitudinal cracks
- Knobs
- Banana, pear or folded shapes
- High doses = popcorn-shaped tubers or chains of tubers

Soil carryover


Imazamox
0.03 L/a


0.03 L/a

Growth regulators: Group 4

- Phenoxy
  - 2,4-D*
- Benzoic acids
  - Banvel* (dicamba)
- Carboxylic acids
  - Curtail* (clopyralid), Restore II* (aminopyralid)

*and other labeled herbicides

2,4-D effect on foliage

- Wrinkled and cupped leaves
- Parallel venation (long, narrow appearance)
- Bending and twisting of stems and petioles

2,4-D effect on tubers

- Deeper eyes
- Slightly smaller tuber size
- Increases anthocyanins and deeper red color


2,4-D
0.24 L/a

Dicamba effect on foliage

- Wrinkled and cupped leaves
- Parallel venation (long, narrow appearance)
- Curling of leaflets
- Bending and twisting of stems and petioles
- Fiddlenecking (folded, hooded appearance)

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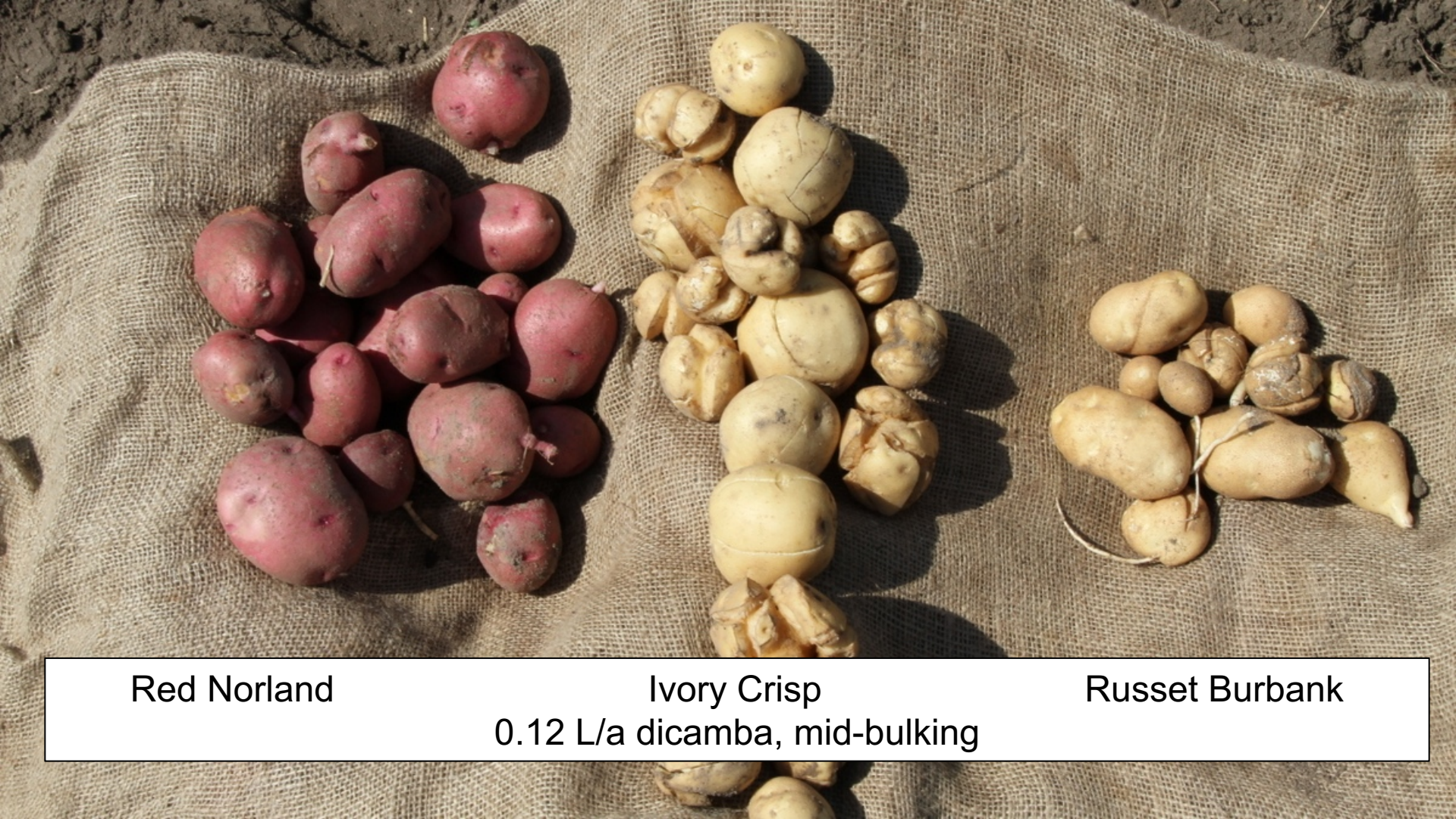
Dicamba effect on tubers

- Elephant hide
- Smaller tubers
- Malformed and cracked tubers


Red Norland
Ivory Crisp
Russet Burbank
0.12 L/a dicamba, mid-bulking


Red Norland
0.12 L/a dicamba


Russet Burbank
Non-treated

Russet Burbank
Dicamba 0.02 L/a

Dicamba residues in seed

- Slow emergence
- Twisted, bent stems
- Leaves often crinkled, twisted, cupped and malformed.

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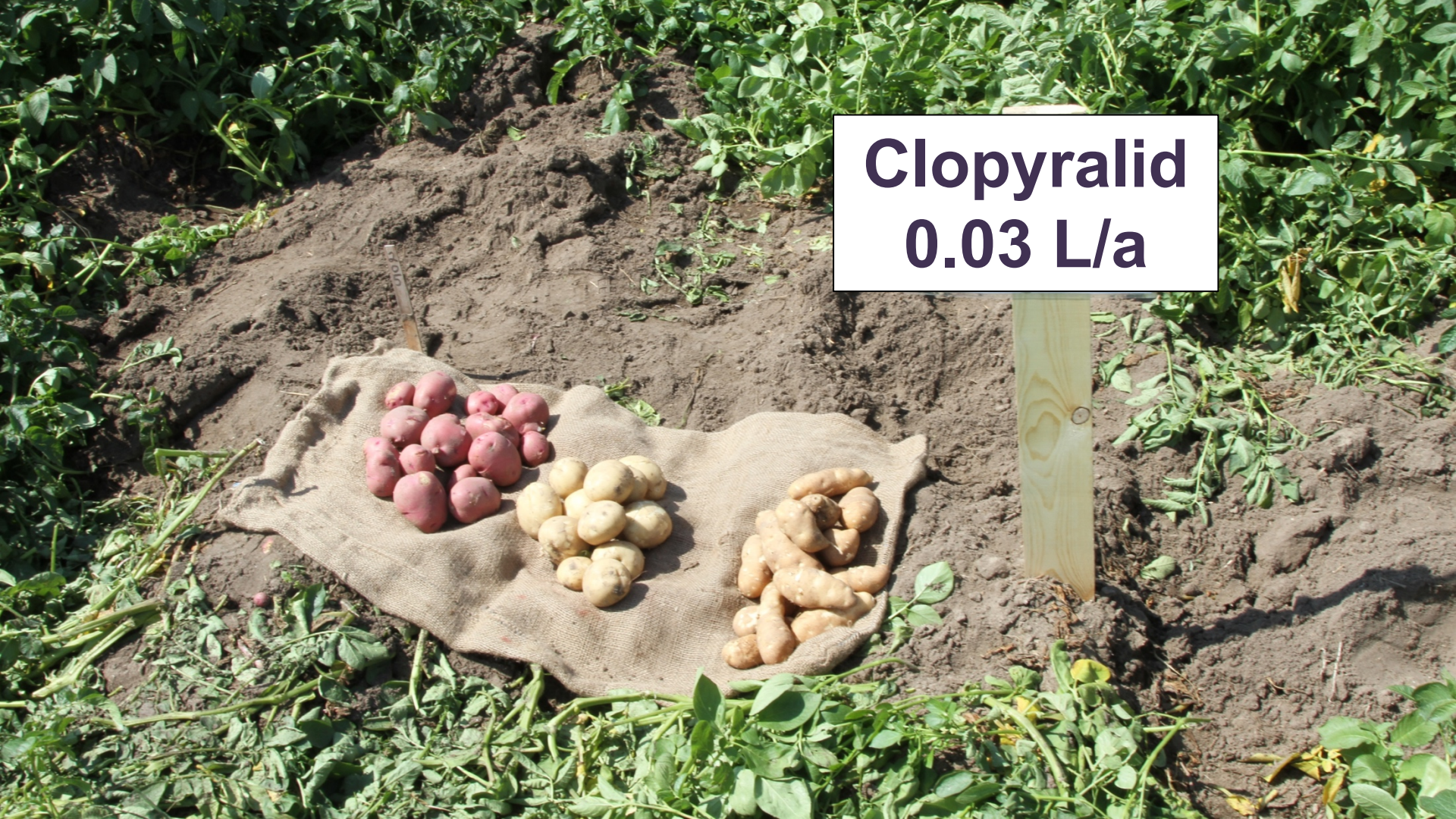
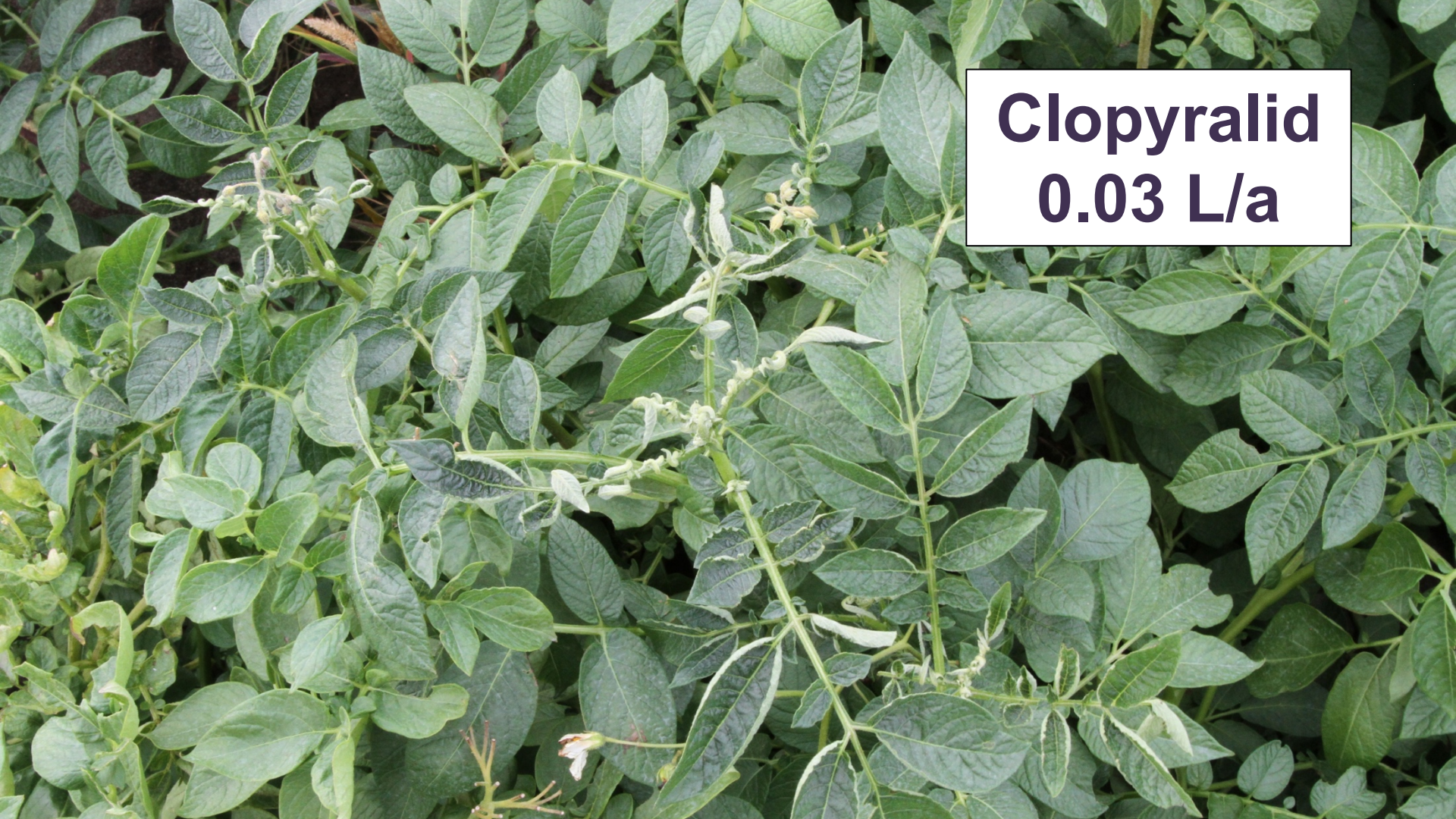
Carboxylic acids effect on foliage

- Severely wrinkled and cupped leaves
- Curling of leaflets
- Bending and twisting of stems and petioles
- Stems and leaves may thicken

Carboxylic acids effect on tubers

- Deeper eyes
- Smaller tubers
- Malformed and cracked tubers
- Pointed ends
- Circles may develop around the eyes (bullseye)


Clopyralid
0.03 L/a


Clopyralid
0.03 L/a


Clopyralid
0.03 L/a

PS II inhibitors: Group 5, 6, 7

- Triazines
  - atrazine
- Triazinones
  - Sencor (metribuzin)*
- Ureas
  - Lorox* (Linuron),

*and other labeled herbicides

Metribuzin activity

More active in soils with:

1. pH > 7.5
2. Low organic matter
3. Stressed plants

Foliar: symptoms can be severe when metribuzin is applied when plant metabolism is slowed, or within 3 days after periods of cool, wet, or cloudy weather.

Metribuzin injury


Metribuzin injury


Linuron injury


Linuron injury

Glyphosate effect on foliage

- Yellowing of new leaflets
- Stunting of plant growth
- Higher rates cause leaves to become chlorotic and necrotic
- Reduction in plant height and leaf size

Glyphosate effect on tubers

- Smaller tubers
- Irregularly shaped tubers that have folds, cracks, knobs and elephant hide

Glyphosate – 2nd generation

- Erratic and slow emergence pattern
- Bending, twisting, and yellowing of leaves
- Multiple stems from an eye
- ‘Cauliflower’ or ‘candelabra’ formation of stems
- Enlarged stems

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Glyphosate – 3rd generation

- Have not observed any symptoms

2nd generation

3rd generation

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Visual injury ≠ yield

- “Vegetative responses did not accurately predict yield and quality responses of tubers.” (Pfleeger et al., 2008)
- “An inconsistent relationship was observed for herbicide related injury and tuber yield reductions of mother potato plants with daughter tuber growth and yield.” (Colquhoun et al., 2017)

How to protect potatoes

- Talk with neighbors
- Dedicate a sprayer for potatoes – using only potato friendly herbicides
- Plant borders around fields
- Train employees about herbicide problems
- Scout regularly and especially walk field edges
- Place signs around field

Thank you

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