Weed Management in Potatoes: Addressing Current & Future Realities

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Weed control methods

- Prevention
- Cultural
- Mechanical / physical
- Chemical
- Biological

Primary Weed Control Method

Product region (US)	Mechanical (%)		Chemical (%)	
	1964	1969	1964	1969
Western	93	70	3	10
Central	97	90	2	5
Southern	80	30	-	-
Northeast	50	20	20	20

(Dallyn, 1971)

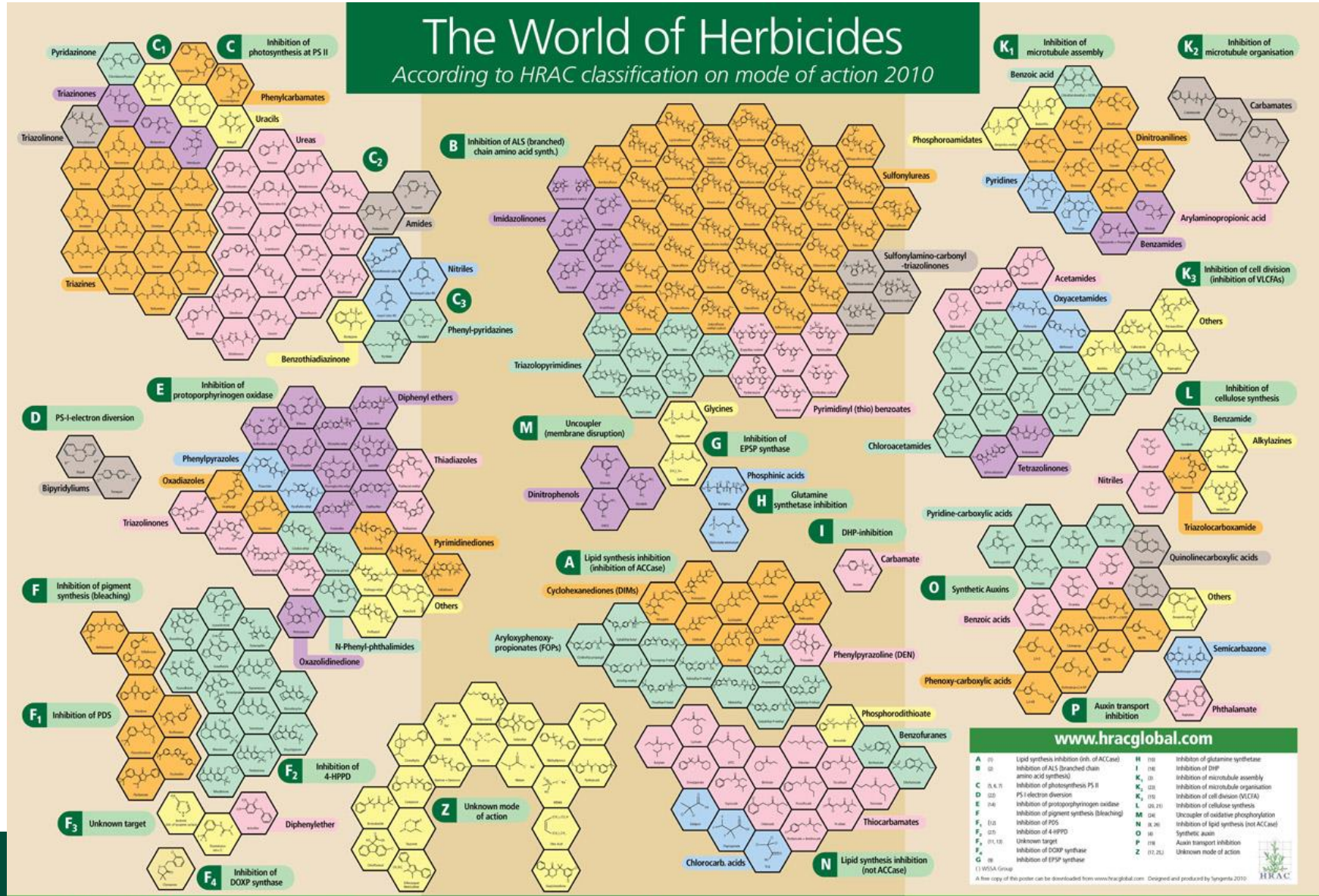
Weed control

- Tillage/hilling
  - Remove emerging weeds
  - Incorporate herbicides & fertilizers
  - Prevent greening

http://www.allanequipment.com/new-products/new-new-product-page/

What's the herbicide situation?

- Many herbicides.
- Limited for potato.
- So what does this mean?



PRE emergence options

Group	Chemical	Product
8	EPTC	Eptam 8E
9	Glyphosate	Roundup*
15	Dimethenamid-P	Outlook
7	Linuron	Lorox
15	S-metolachlor	Dual II Magnum
5	Metribuzin	Sencor*
5, 14	Metribuzin + sulfentrazone	Sencor STZ
10	Glufosinate ammonium	Ignite
*other generics		

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HERBICIDES

SEE NOTES AND PRODUCT LABELS FOR DETAILS ON HERBICIDES

*Weed Control Rating

E - Excellent
G - Good
F - Fair
P - Poor

	Chemical Name	Product Name (s)	Formulation	Product/ha	Weed Control Rating: annual broad leaves: chickweed	hempnettle	lambsquarters	mustard family	pigweeds	ragweeds	smartweed fami	wild buckwheat	wild radish	annual grasses: barnyard grass	foxtail	crabgrass	Perennials: quackgrass	Canada thistle	sow thistle	goldenrod	field mint	Potato tolerance	Acute Hazard rating Mammals	Reentry Time (hrs)
BEFORE PLANTING	EPTC	Eptam 8E	EC	4.25 - 8.5 L/ha	F	-	F	P	F	F	F	P	P	G	G	G	F	P	P	-	-	E	VLH	12
	glyphosate	Roundup Weathermax / Ultra 2	SN	0.5 -2.33 L	+	+	+	+	+	+	+	+	+	+	+	+	G	P	E	+	+	P	VLH	12
		Touchdown iQ	SN	0.75 -3.5 L	+	+	+	+	+	+	+	+	+	+	+	+	G	P	E	+	+	P	VLH	
		Roundup Weathermax / Ultra 2	SN	1.67 - 4.67 L	+	+	+	+	+	+	+	+	+	+	+	+	E	E	E	+	+	P	VLH	
		Touchdown iQ	SN	2.5 - 7.0 L	+	+	+	+	+	+	+	+	+	+	+	+	E	E	E	+	+	P	VLH	12
	glyphosate + an approved surfactant	Roundup Weathermax / Ultra 2 or Touchdown iQ + an approved surfactant	SN SURF	As per label when using high water volumes as per surfactant label	+	+	+	+	+	+	+	+	+	+	+	+	E	P	E	+	+	P	-	-
	s-metolachlor	Dual Magnum (915g/L)	EC	1.25-1.75L/ha	P	P	-	-	-	-	-	P	-	G	G	G	P	-	P	P	P	G	VLH	24
PLANTING TO EMERGENCE	dimethenamid-P	Outlook	EC	0.756 - 0.963 L/ha					F					E	E	E						G		24
	linuron	Lorox L (480g/L) or Linuron 480 FL (480g/L)	SU	2.3 - 4.6L/ha	G	G	E	E	G	G	E	E	F	F	F	F	P	-	P	P	P	F	VLH	24
		Lorox (50%)DF	DF	2.2 - 4.3 kg/ha																				
		Linuron 400FL(400g/L)	SU	2.5 - 5.2 L/ha																				
	Linuron + s-metolachlor	Lorox L (480 g/L) or Lorox DF (50%) + Dual II Magnum	SU DF EC	1.8 - 2.3 L/ha 1.75 - 2.25 kg/ha + 1.25 - 1.75 L/ha	G	G	E	E	E	G	E	G	G	E	E	E	P	P	P	P	P	E	LH	-
	metribuzin	Sencor 75DF	DF	0.55 - 1.5 kg/ha	G	E	E	E	E	E	E	G	E	G	G	G	P	-	P	-	P	G	VLH	12
		Sencor Solupak 75 DF	DF	0.55 - 1.5 kg/ha																				
		Sencor 480F	SU	0.84 - 2.2 L/ha																				
		TriCor 75 DF	DF	0.75 - 1.5 kg																				
	metribuzin + s-metolachlor	Sencor 75DF Sencor 480 F TriCor 75 DF	DF SU DF	0.75 - 1.5 kg/ha or 1.1 - 2.25 L/ha + 0.75 - 1.5 kg	G	E	E	E	E	E	E	G	G	E	G	G	P	-	P	-	P	G	LH	-
		+Dual II Magnum	EC	1.25 - 1.75 L/ha																				
	metribuzin + linuron	Sencor 75DF or Sencor Solupak 75DF or Sencor 480F + linuron 480	DF DF SU SU	0.55 - 1.1 kg/ha 0.55 - 1.1 kg/ha 0.85 - 1.75 L/ha + 1.6 - 3.75 L/ha	G	E	E	E	E	E	E	E	E	G	G	G	P	-	P	-	P	G	VLH	-

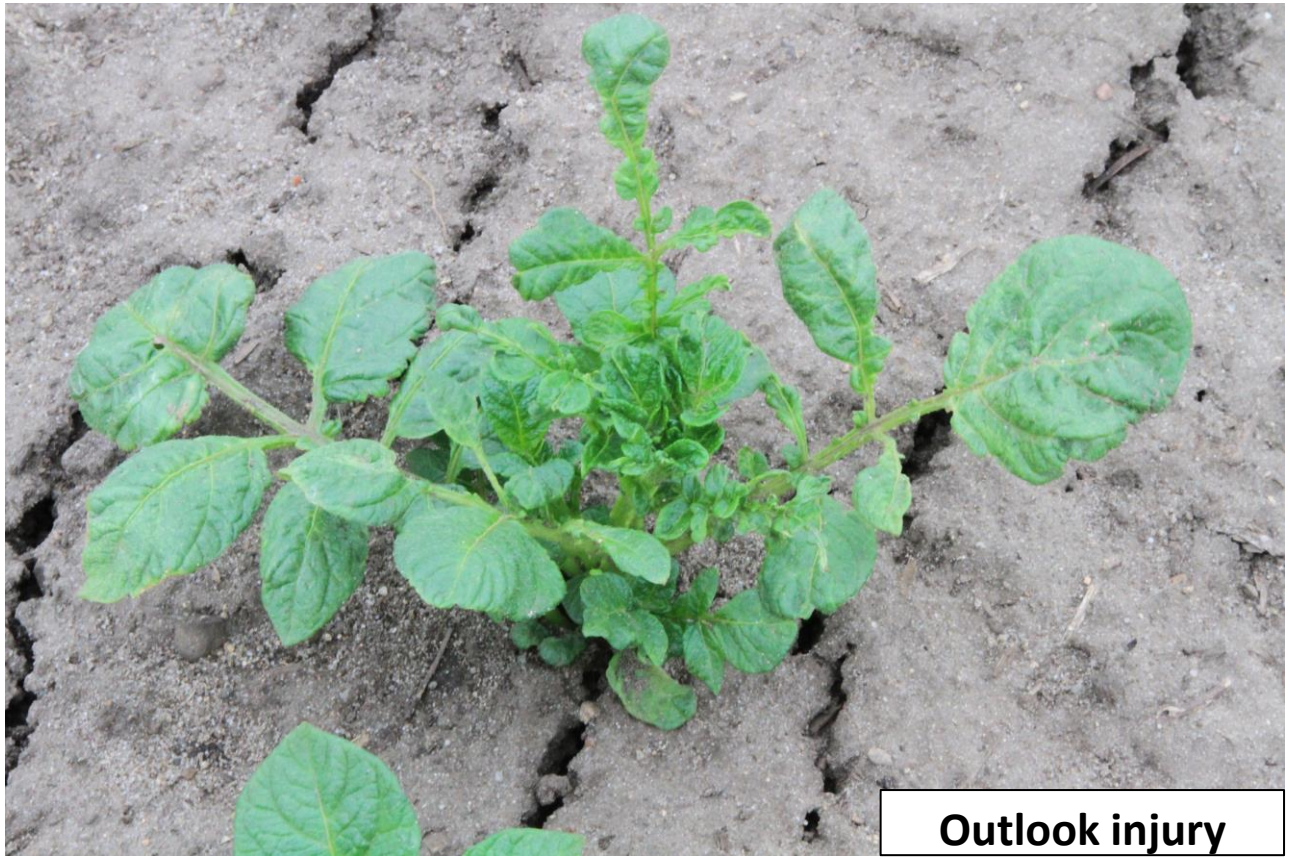
Outlook

- Inhibit proper cell division. It is believed these herbicides inhibit synthesis of very-long-chain-fatty acids during cell division.

- Provide good to excellent control of
  - Common lambsquarters
  - Pigweed species
  - Nightshade species

Dual/Outlook

- Bound to OM
- Broken down by soil microbes
- Breaks down quicker in warm temperatures
- Root & shoot inhibitor



Outlook injury


Outlook injury
(dimethenamid-P)

Crop injury from Outlook and Dual

Treatment		Rate	Russet Burbank		
			Crop Injury		
			6/8/17	6/22/17	6/29/17
			%		
1	Non-treated check		0	0	0
2	Zidua Matrix	3.5 FL OZ/A 1.5 OZ/A	1	2	1
3	Zidua Outlook	3.5 FL OZ/A 21 OZ/A	7	0	1
4	Zidua Metribuzin	3.5 FL OZ/A 0.5 LB/A	0	1	2
5	Zidua Metribuzin Outlook	3.5 FL OZ/A 0.33 LB/A 16 OZ/A	7	0	0
6	Zidua Dual EC	3.5 FL OZ/A 1 PT/A	8	0	1
7	Sulfentrazone	2 OZ/A	8	0	2
LSD at p=0.05			4	ns	ns

Yield of Russet Burbank

Treatment		Rate	Total yield	Total Marketable	>6 oz
			---------- Cwt/a ----------		----- % -----
1	Non-treated check		346	205	18
2	Zidua Matrix	3.5 FL OZ/A 1.5 OZ/A	582	493	59
3	Zidua Outlook	3.5 FL OZ/A 21 OZ/A	501	425	56
4	Zidua Metribuzin	3.5 FL OZ/A 0.5 LB/A	491	417	57
5	Zidua Metribuzin Outlook	3.5 FL OZ/A 0.33 LB/A 16 OZ/A	528	452	54
6	Zidua Dual EC	3.5 FL OZ/A 1 PT/A	585	491	54
7	Sulfentrazone	2 OZ/A	484	416	56
LSD at p=0.05			ns	84	8

Russet Burbank Crop Injury & Yield

Treatment	Rate (kg/ha)	Timing	Injury (%)	Yield (kg/ha)
1986				
Metolachlor + linuron	2.2 + 1.1	PRE	0	53.1
Metolachlor + linuron	2.2 + 1.1	Cracking	0	54.5
Non-treated			0	38.0
1987				
Metolachlor + linuron	2.2 + 1.1	PRE	0	26.8
Metolachlor + linuron	2.2 + 1.1	Cracking	0	42.4
Non-treated			0	8.2

(Renner, 1992)

Linuron + Rimsulfuron

- Linuron (420 g/ha) + rimsulfuron (35 g/h)
  - Lambsquarters 87-93% control
  - Common ragweed 76-89% control
  - Superior yield was similar when comparing metribuzin + rimsulfuron to linuron + rimsulfuron in both years (1992 = 30.4 vs. 28.3; 1993 = 11.7 vs. 13.1 kg/ha)

(Ackley et al., 1996)

Timing of herbicides

- 3 – 5 week window for PREs
- Program could include:
  - Herbicide at plant
  - Herbicide prior to emergence
  - Postemergence herbicide

Soil factors for preemergence herbicides

- pH
- Organic matter
- Soil texture

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

POST emergence options

Group	Chemical	Product
1	Clethodim	Select*
1	Fluazifop	Venture L
2	Rimsulfuron	Prism
1	Sethoxydim	Poast*
5	Metribuzin	Sencor*
8	EPTC	Eptam
*other generics		

HERBICIDES (pg 2)

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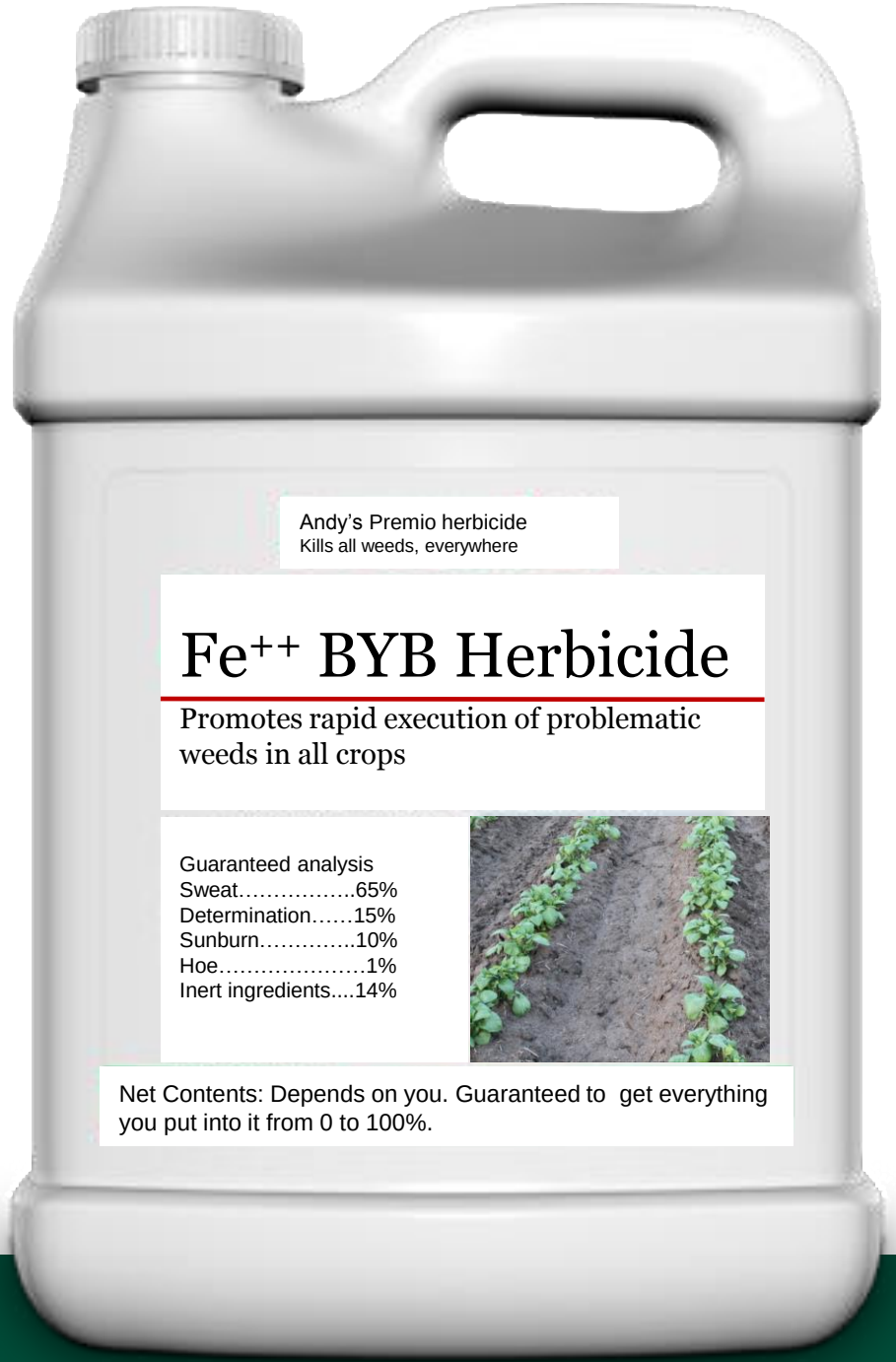
SOON AFTER EMERGENCE CHECK NOTES FOR PRECAUTIONS	metribuzin	Sencor 75DF	DF	0.55 - 1.5 kg/ha	G	E	E	E	E	E	E	G	E	G	-	-	F	-	P			F	VLH	12
		Sencor Solupak 75DF	DF	0.55 - 1.5 kg/ha																				
		Sencor 480F	SU	1.2 - 2.2 L/ha																				
		TriCor 75 DF	DF	0.55 - 1.5 kg/ha																				
	paraquat	Gramoxone (200g/L)	SN	2.8 - 4.25 L/ha	+	F	G	G	G	-	F	F	F	F	-	-	G	-	F	-	F	F	LH	24
POST-EMERGENCE	clethodim (annual grass 2 -6 leaf)	Arrow/X-Factor***	EC + SURF	0.19 L/ha + 0.5% v/v	P	P	P	P	P	P	P	P	P	E	E	E	F	P	P	P	P	E	VLH	24
	clethodim (quackgrass 3-5 leaf)	Arrow/X-Factor***	EC + SURF	0.38 L/ha + 1.0% v/v	P	P	P	P	P	P	P	P	P	E	E	E	E	P	P	P	P	E	VLH	24
	clethodim (annual grass 2 -6 leaf)	Select/Amigo***	EC + SURF	0.19 L/ha + 0.5% v/v	P	P	P	P	P	P	P	P	P	E	E	E	F	P	P	P	P	E	VLH	24
	clethodim (quackgrass 3-5 leaf)	Select/Amigo***	EC + SURF	0.38 L/ha + 1.0% v/v	P	P	P	P	P	P	P	P	P	E	E	E	E	P	P	P	P	E	VLH	24
	fenoxaprop-p-ethyl	Excel Super **, ***	EC	0.67 L/ha	P	P	P	P	P	P	P	P	P	E	E	E	P	P	P	P	P	E	VLH	24
	fluazifop-p-butyl (Annual Grass 2-5 leaf)	Venture L***	EC	1.0L/ha	P	P	P	P	P	P	P	P	P	E	E	G	F	P	P	P	P	E	VLH	24
	fluazifop-p-butyl Quackgrass(3-5 leaf)	Venture L***	EC	2.0 L/ha	P	P	P	P	P	P	P	P	P	E	E	G	E	P	P	P	P	E	VLH	24
	rimsulfuron + Surf	Prism*** + Surf	DF + SURF	60 g/ha + 2L/1000L	G	-	F	G	G	-	-	-	E	E	E	E	G	-	-	E	-	G	LH	4
	sethoxydim + Merge or Assist (Annual Grasses 2-5 leaf)	Poast Ultra***+ Merge or Assist	EC Surf Surf	0.47 L/ha+ 1 L/ha 1 L/ha	P	P	P	P	P	P	P	P	P	E	E	E	P	P	P	P	P	E	VLH	12
	sethoxydim + Merge or Assist (wild oats and volunteer cereals)	Poast Ultra***+ Merge or Assist	EC Surf Surf	0.32 L/ha + 1 L/ha 1L/ha	P	P	P	P	P	P	P	P	P	E	E	E	F	P	P	P	P	E	VLH	12
	sethoxydim + Merge or Assist (Quackgrass 1-3 Leaf)	Poast Ultra***+ Merge or Assist	EC Surf Surf	1.1 L/ha + 1 - 2 L/ha 1-2 L/ha	P	P	P	P	P	P	P	P	P	E	E	E	E	P	P	P	P	E	VLH	12
UP TO 60 DAYS BEFORE HARVEST	EPTC at lay-by	Eptam 8E	EC	4.2 - 5.6 L/ha	F	-	G	P	F	F	F	P	P	G	G	G	F	P	P	-	-	E	VLH	12


Do you think herbicide resistance is a problem? Why or why not?

What are you doing to prevent herbicide resistance?

Best product

- Fe^{++} BYB
- Excellent control of nightshade
- Works best on small weeds
- Can cause some crop injury if not careful




WINGSCAPES
SPUD1
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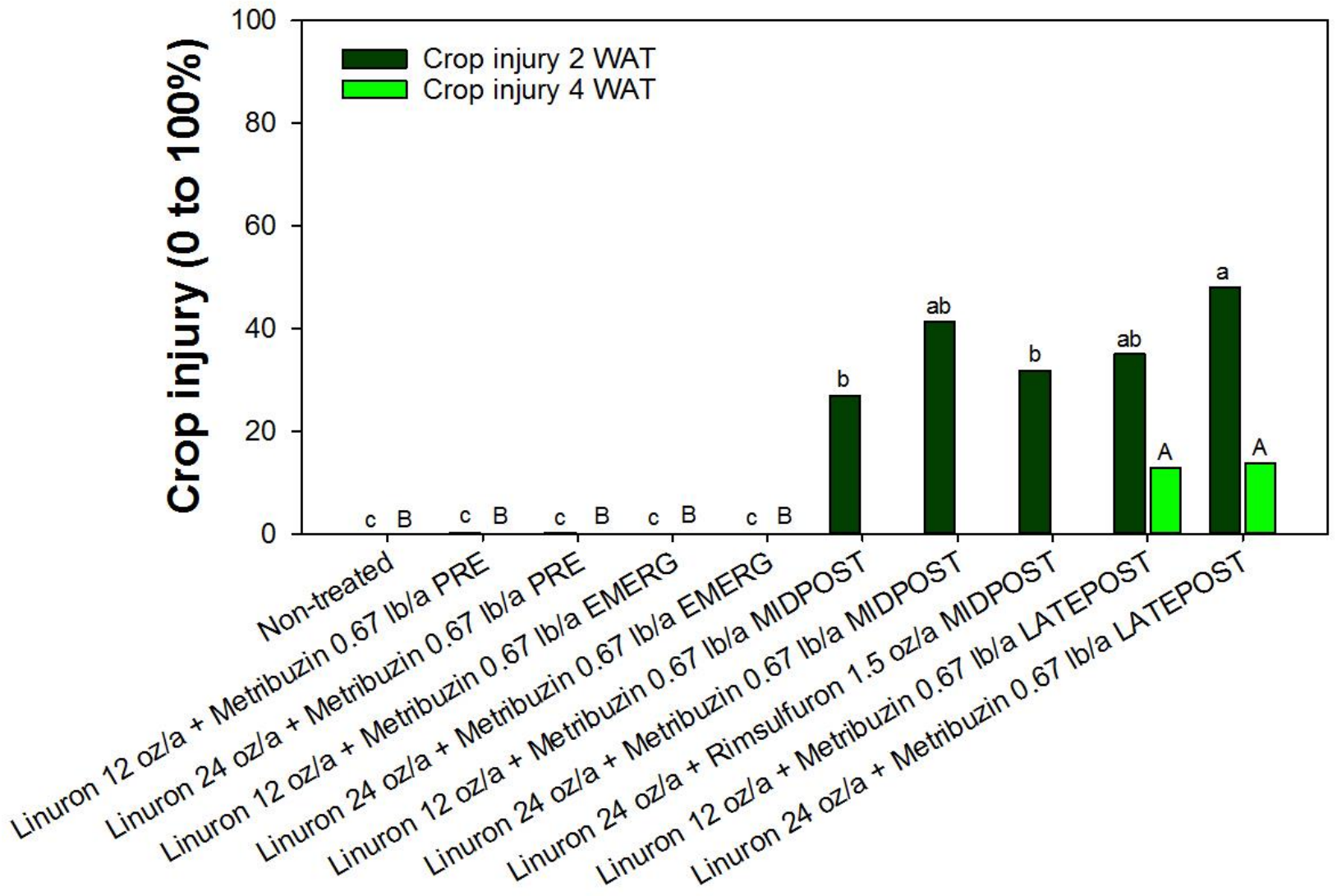
How to optimize weed control?

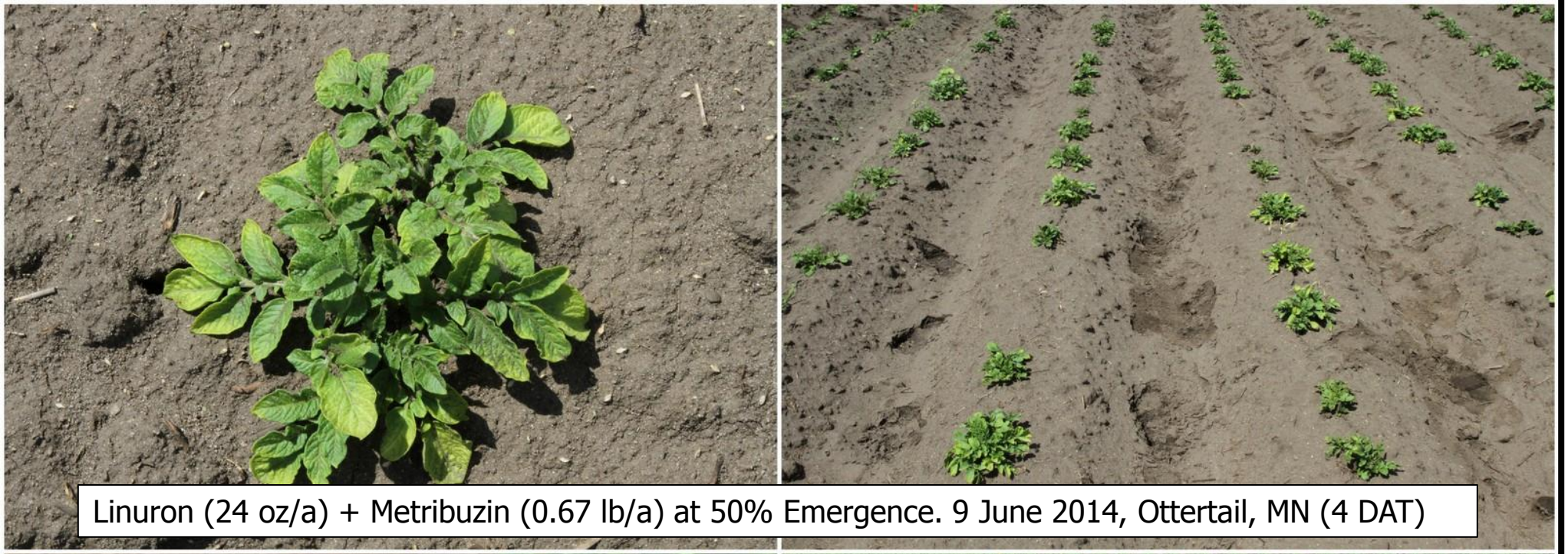
- Use an integrated weed management approach with many tools.
  - Tillage
  - Best herbicides at right time
  - Cultural management practices
  - Do not encourage herbicide resistance

One-pass hilling

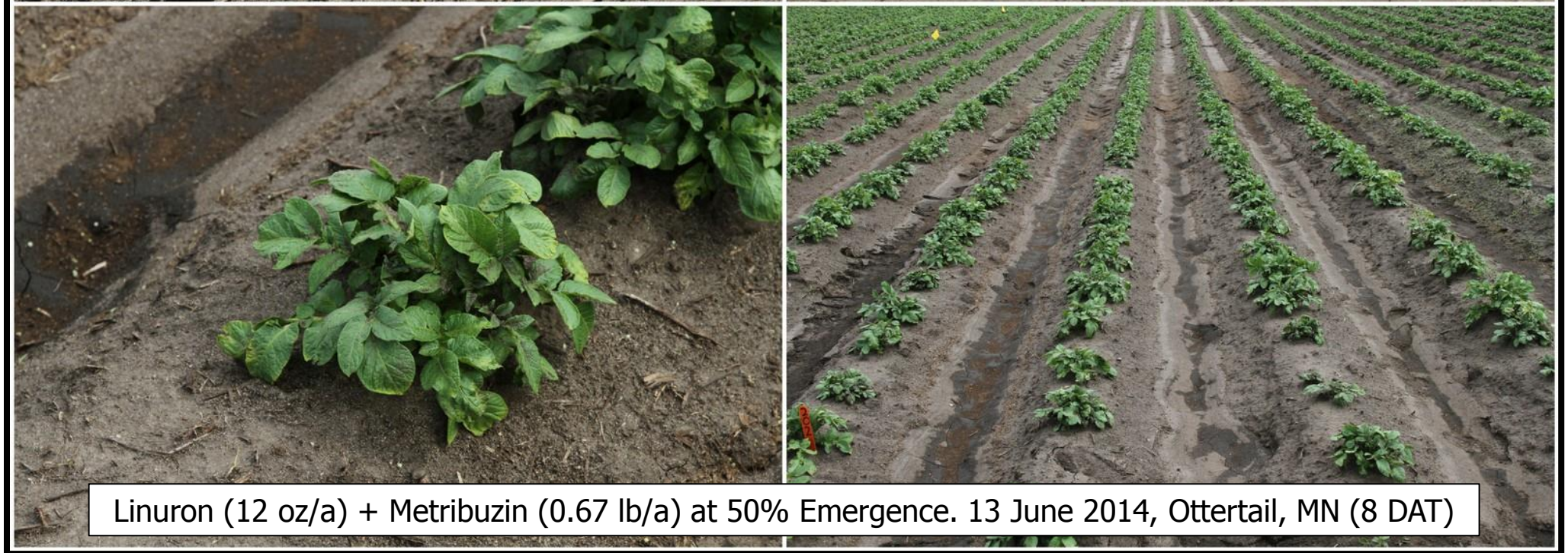
- Similar to bed planting
  - Greater reliance on herbicides
    - Timing is essential
  - Reduce weed seed bank in rotation years
  - Encourage quick emergence and canopy closure
  - Could plant narrower rows or try bed planting

Herbicide timing





Linuron (24 oz/a) + Metribuzin (0.67 lb/a) at 50% Emergence. 9 June 2014, Ottertail, MN (4 DAT)



Linuron (12 oz/a) + Metribuzin (0.67 lb/a) at 50% Emergence. 13 June 2014, Ottertail, MN (8 DAT)

Non-treated

Linuron 12 oz/a +
Metribuzin 0.67 lb/a 4
WAT preemergence

Linuron 12 oz/a +
Metribuzin 0.67 lb/a 3
WAT emergence

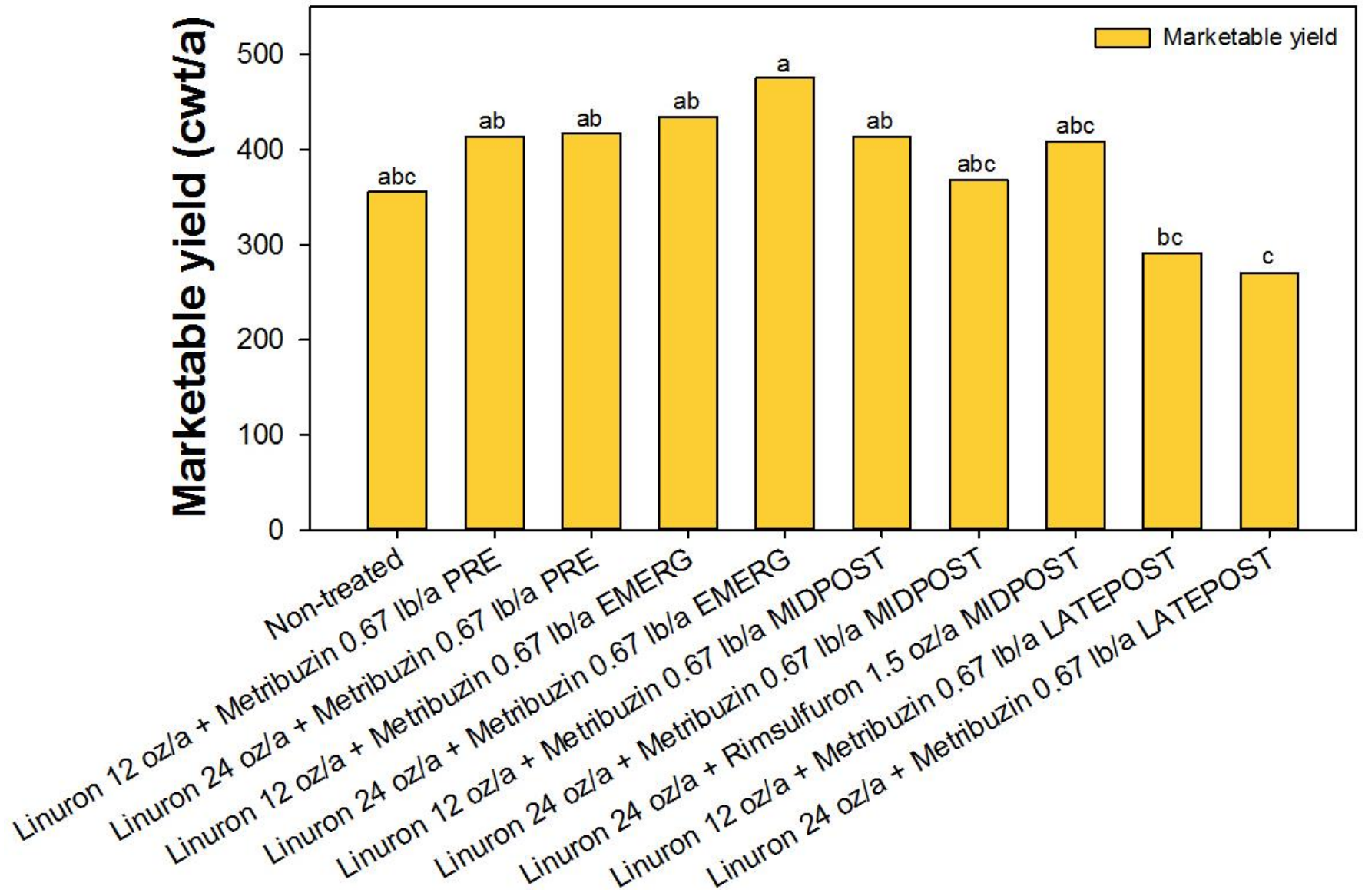
Linuron 12 oz/a +
Metribuzin 0.67 lb/a 1
WAT 8-10 in tall
postemergence

Linuron 24 oz/a +
Metribuzin 0.67 lb/a 4
WAT preemergence

Linuron 24 oz/a +
Metribuzin 0.67 lb/a 3
WAT emergence

Linuron 24 oz/a +
Metribuzin 0.67 lb/a 1
WAT 8-10 in tall
postemergence

Chlorosis caused by
linuron


Marketable yield (cwt/a)
500
400
300
200
100
0
Marketable yield
abc
ab
ab
ab
a
ab
abc
abc
bc
c
Non-treated
Linuron 12 oz/a + Metribuzin 0.67 lb/a PRE
Linuron 24 oz/a + Metribuzin 0.67 lb/a PRE
Linuron 12 oz/a + Metribuzin 0.67 lb/a EMERG
Linuron 24 oz/a + Metribuzin 0.67 lb/a EMERG
Linuron 12 oz/a + Metribuzin 0.67 lb/a MIDPOST
Linuron 24 oz/a + Metribuzin 0.67 lb/a MIDPOST
Linuron 24 oz/a + Rimsulfuron 1.5 oz/a MIDPOST
Linuron 12 oz/a + Metribuzin 0.67 lb/a LATEPOST
Linuron 24 oz/a + Metribuzin 0.67 lb/a LATEPOST

Adjuvants

- Uptake of paraquat was increased with an adjuvant.
- Most postemergnece herbicides need an adjuvant to increase activity.

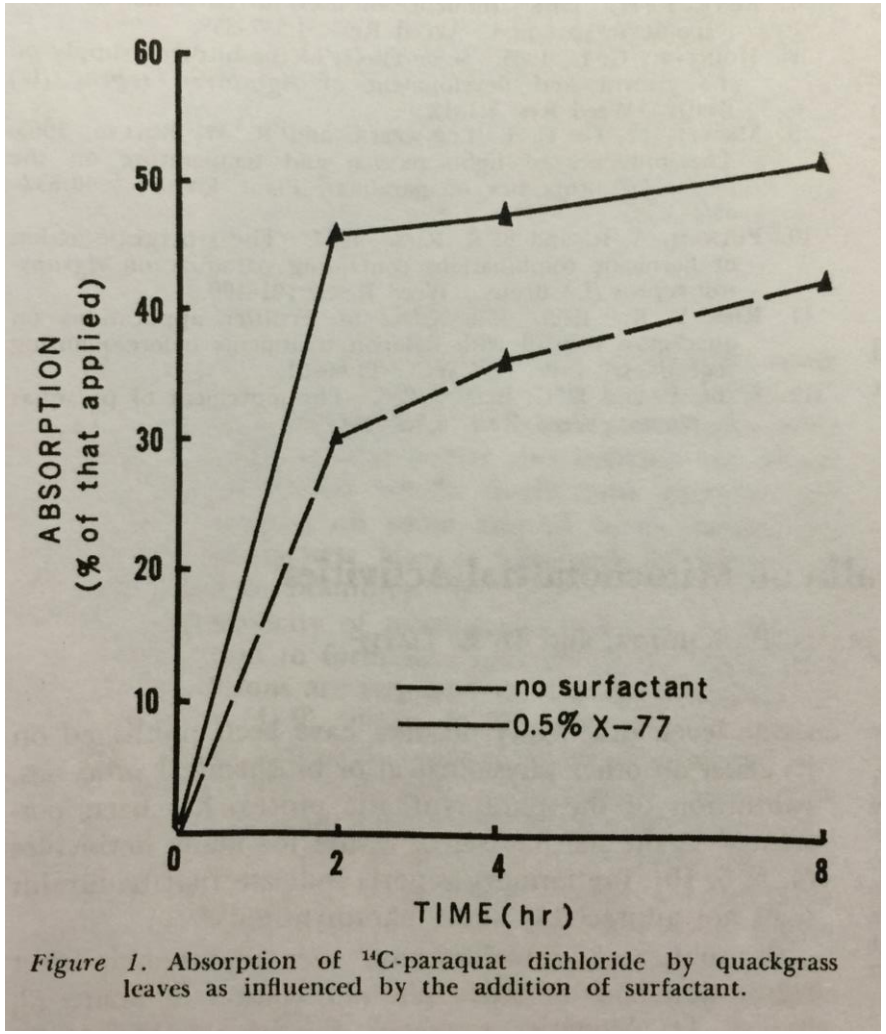


Figure 1. Absorption of ^{14}C-paraquat dichloride by quackgrass leaves as influenced by the addition of surfactant.

(Putnam and Ries, 1968)

Tips for maximum efficacy

- Incorporate (tillage or water)
- Timing
  - PRE: prior to emergence (follow label)
  - POST: small weeds, <1 inch tall is ideal
- Use adjuvants with POST herbicides
- Tank mix herbicides to improve weed control spectrum

Improve efficacy & reduce crop injury

- Not controlling weeds can cause up to 73% yield loss
- How much crop injury can you take?

Exposure to herbicides

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

Soil carryover

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

Drift

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

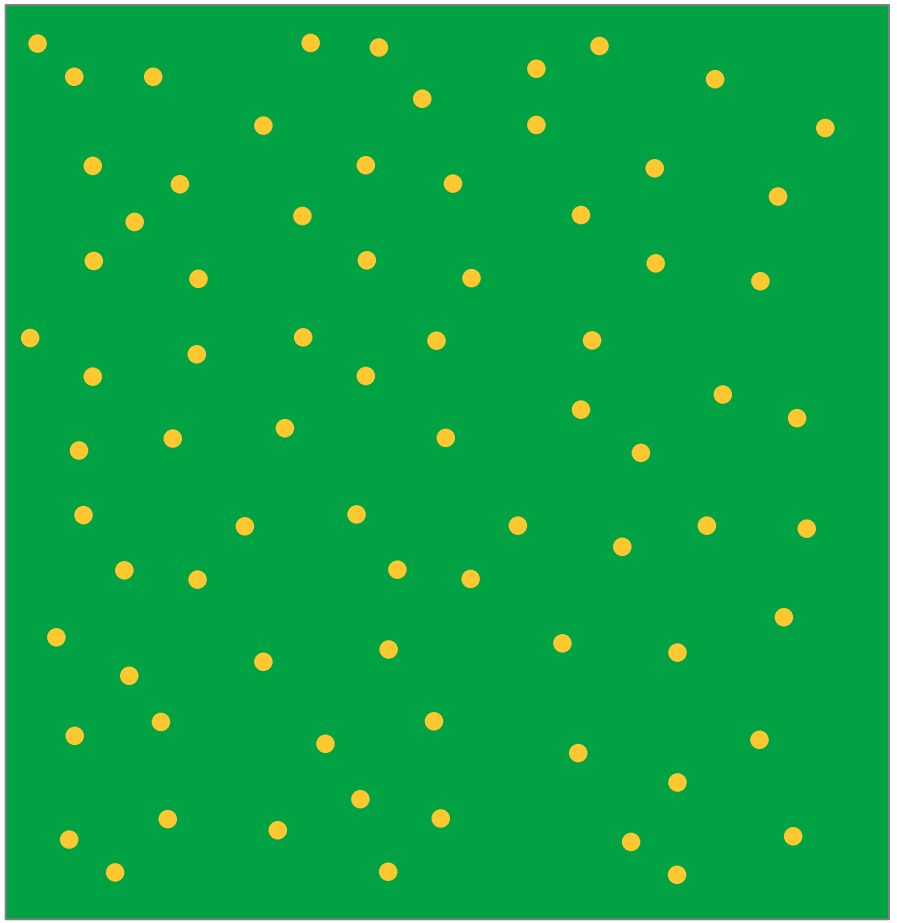

Tank contamination

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

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)

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

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 (reduced yield sometimes)
- Irregularly shaped tubers that have folds, cracks, knobs and elephant hide

Glyphosate – 1st generation exposure

- Leaves may become chlorotic/necrotic
- Reduction in plant height, leaf size
- Tubers can be malformed
- Yields are often reduced

Glyphosate – 2nd generation

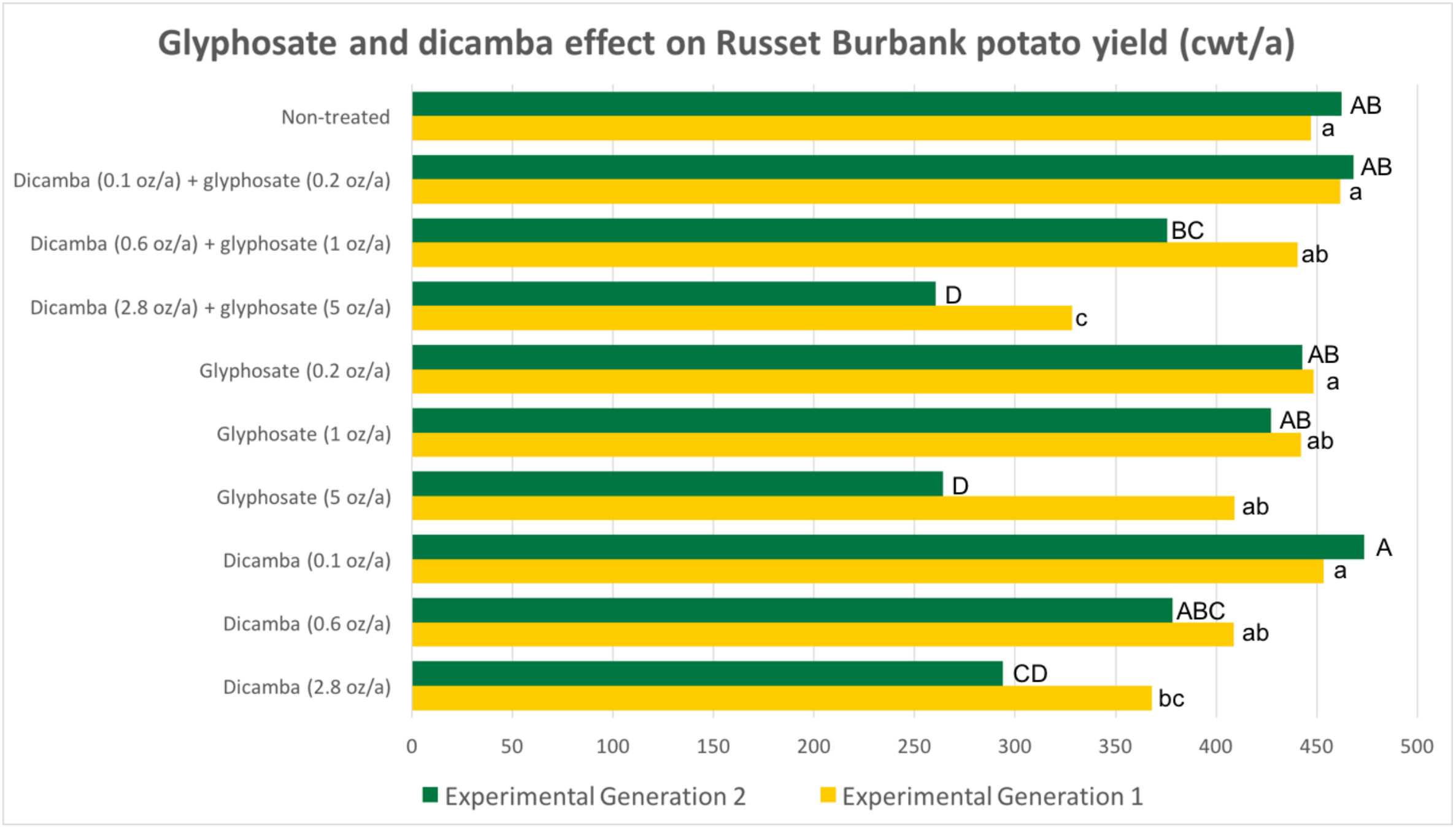
- Erratic and slow emergence pattern
- Bending, twisting, and yellowing of leaves
- Multiple stems from an eye
- ‘Cauliflower’ or ‘candelabra’ formation of stems
- Enlarged stems

Glyphosate – 3rd generation

- Have not observed any symptoms

2nd generation

3rd generation


Glyphosate and dicamba effect on Russet Burbank potato yield (cwt/a)
Non-treated
Dicamba (0.1 oz/a) + glyphosate (0.2 oz/a)
Dicamba (0.6 oz/a) + glyphosate (1 oz/a)
Dicamba (2.8 oz/a) + glyphosate (5 oz/a)
Glyphosate (0.2 oz/a)
Glyphosate (1 oz/a)
Glyphosate (5 oz/a)
Dicamba (0.1 oz/a)
Dicamba (0.6 oz/a)
Dicamba (2.8 oz/a)
AB
a
AB
a
BC
ab
D
c
AB
a
AB
ab
D
ab
A
a
ABC
ab
CD
bc
0
50
100
150
200
250
300
350
400
450
500
Experimental Generation 2
Experimental Generation 1

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


Questions?
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