Getting the Most out of Lorox (Linuron)

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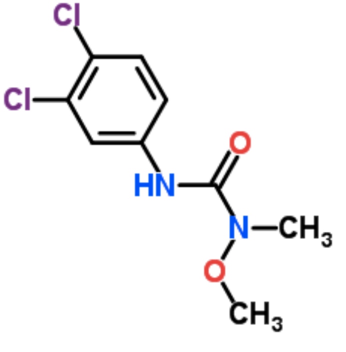
Is the Old the New?

- Linuron: 1962 (same year as diquat)
- Today known as Lorox in Canada
- Used in carrots and potatoes and other vegetables.
- ~2/3 potato acres in Canada use Lorox
  - less soluble in water
  - Resistance management



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Old Literature Titles

- **The Place of Herbicides in the Potato Crop** (Stephens, 1965)
- **The Development of Herbicides for Potato** (Cox and Elliott, 1965)
- **Weed Control Methods in Potato** (Dallyn, 1971)

Primary Weed Control Method

Product region	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)				

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Linuron

Advantages

- Inhibitor of photosystem II, site B (group 7)
- Less potato crop tolerance issues with linuron
- Control weeds that may be hard to kill or resistant to other herbicides
- 1/12th as soluble as metribuzin

Challenges

- No aerial application allowed
- Cost
- Doesn't work as well in soils with high clay content or high OM
- Labeled as preemergence

Why Is There Interest?

- Herbicide-resistant weeds
  - No new modes of action in 20+ years
- Reduced solubility
- Weed spectrum
- Later herbicide application

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Linuron Timing

Metolachlor + linuron

- Preemergence had varied weed control in barnyard grass, redroot pigweed, and lambsquarters (23-100%).
- Cracking treatment found good control of barnyardgrass, redroot pigweed, and common lambsquarters (93-100%).

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(Renner, 1992)

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

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(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 linruon + rimsulfuron in both years (1992 = 30.4 vs. 28.3; 1993 = 11.7 vs. 13.1 kg/ha)

(Ackley et al., 1996)

Purpose of This Work

- To determine the effects of linuron tank mixtures and timings on:
  - Weed control
  - Crop injury
  - Marketable yield

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Procedures – Tank Mixtures

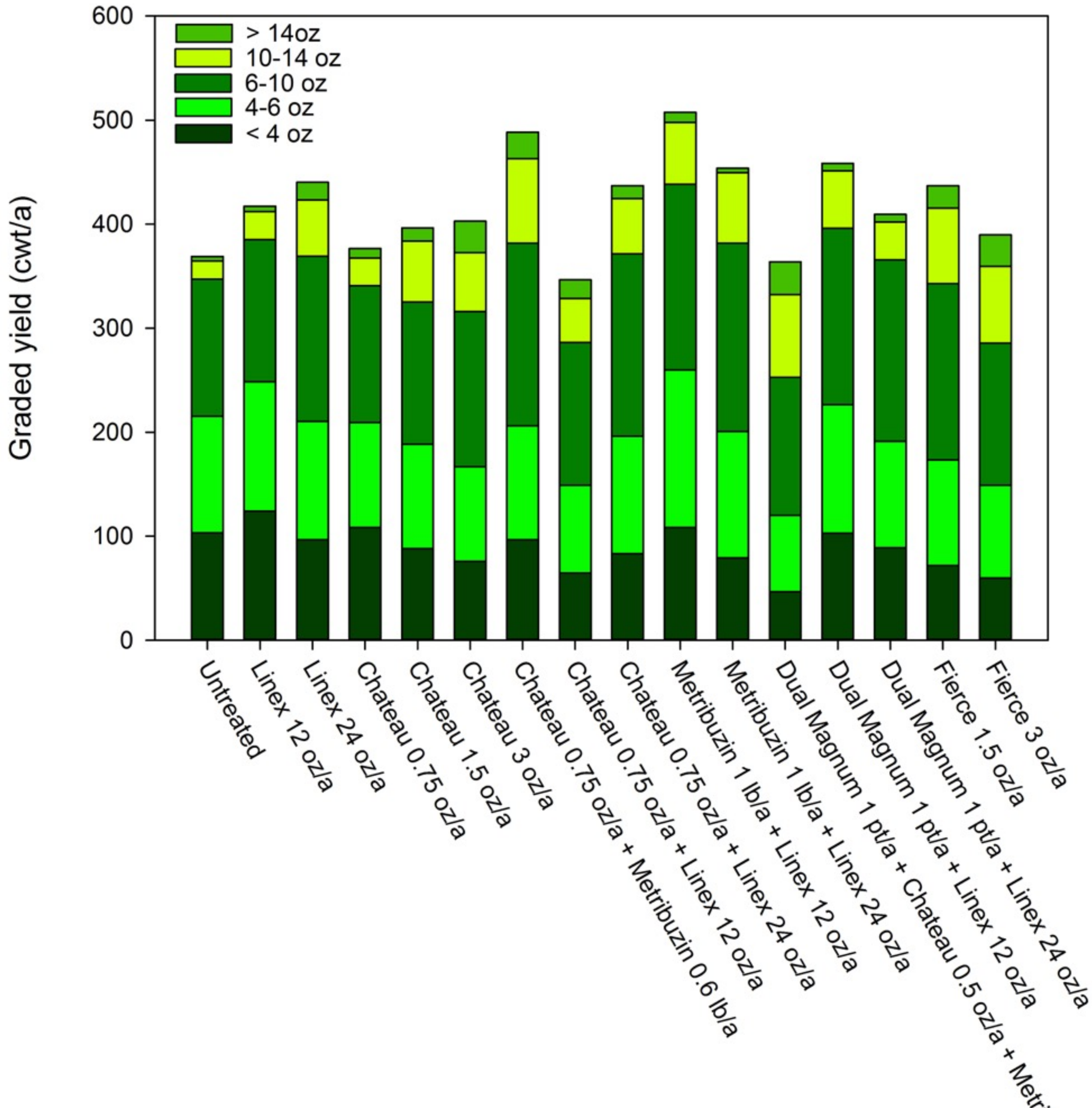
- Location: Perham, MN
- Planting date: 24 May 2013
- Treatment application: 13 June 2013
- All treatments: Applied with a nine-foot CO_2 backpack sprayer calibrated to deliver 15 gal/acre

Weed Control 3 & 5 WAT

Efficacy of preemergence herbicides on Russet Burbank potato grown in Perham, MN 2013.

Treatment	Herbicide treatment	Application rate	Common lambsquarters control[a]				Wild proso millet control			
			3 WAT[b]		5 WAT		3 WAT		5 WAT	
1	Untreated		0	E[c]	0	C	0	C	0	C
2	Linuron 4L	12 oz/a	30	DE	20	BC	67	AB	63	AB
3	Linuron 4L	24 oz/a	55	CD	45	ABC	53	B	58	AB
4	Chateau	0.75 oz wt/a	78	ABC	66	AB	87	AB	75	AB
5	Chateau	1.5 oz wt/a	86	ABC	70	AB	98	A	78	AB
6	Chateau*	3 oz wt/a	99	A	100	A	95	AB	80	AB
7	Chateau Metribuzin	0.75 oz wt/a 0.6 lb/a	99	A	90	A	93	AB	90	AB
8	Chateau Linuron 4L	0.75 oz wt/a 12 oz/a	85	ABC	60	AB	70	AB	40	BC
9	Chateau Linuron 4L	0.75 oz wt/a 24 oz/a	88	AB	64	AB	78	AB	89	AB
10	Linuron 4L Metribuzin	12 oz/a 1 lb/a	96	A	95	A	100	A	91	AB
11	Linuron 4L Metribuzin	24 oz/a 1 lb/a	100	A	100	A	100	A	100	A
12	Dual Magnum Chateau Metribuzin	1 pt/a 0.5 oz wt/a 1 lb/a	90	AB	95	A	100	A	94	AB
13	Dual Magnum Linuron 4L	1 pt/a 12 oz/a	63	BCD	55	ABC	98	A	93	AB
14	Dual Magnum Linuron 4L	1 pt/a 24 oz/a	40	D	78	A	96	A	94	AB
15	Fierce*	1.5 oz/a	85	ABC	73	AB	77	AB	78	AB
16	Fierce*	2.25 oz/a	91	AB	83	A	95	A	83	AB

Graded Yield



Graded Yield of Linuron Trial

Effect of preemergence herbicides on graded yield of Russet Burbank potato in Perham, MN in 2013.

Treatment	Herbicide	Rate	0-4 oz	4-6 oz	6-10 oz	10-14 oz	>14 oz	Total	Total marketable	> 6 oz
			cwt / acre							%
1	Untreated		103 ab[a]	112 ab	132 a	17 b	4 abc	369 ab	268 b	42 b
2	Linuron 4L	12 oz/a	124 a	124 ab	137 a	27 ab	5 c	417 ab	293 ab	41 b
3	Linuron 4L	24 oz/a	97 ab	114 ab	159 a	54 ab	17 abc	440 ab	349 ab	53 ab
4	Chateau	0.75 oz wt/a	108 ab	101 ab	131 a	27 ab	9 abc	377 ab	270 b	45 ab
5	Chateau	1.5 oz wt/a	88 ab	100 ab	137 a	59 ab	13 abc	396 ab	312 ab	53 ab
6	Chateau*	3 oz wt/a	76 ab	91 ab	149 a	56 ab	30 ab	403 ab	332 ab	58 ab
7	Chateau Metribuzin	0.75 oz wt/a 0.6 lb/a	97 ab	109 ab	176 a	81 a	26 ab	489 ab	394 ab	58 ab
8	Chateau Linuron 4L	0.75 oz wt/a 12 oz/a	65 ab	84 b	137 a	42 ab	18 ab	347 b	290 ab	58 ab
9	Chateau Linuron 4L	0.75 oz wt/a 24 oz/a	83 ab	113 ab	175 a	53 ab	12 abc	437 ab	357 ab	55 ab
10	Linuron 4L Metribuzin	12 oz/a 1 lb/a	108 ab	152 a	178 a	59 ab	10 abc	508 a	404 a	49 ab
11	Linuron 4L Metribuzin	24 oz/a 1 lb/a	79 ab	121 ab	181 a	68 ab	4 abc	454 ab	377 ab	56 ab
12	Dual Magnum Chateau Metribuzin	1 pt/a 0.5 oz wt/a 1 lb/a	46 b	74 b	133 a	80 a	31 abc	364 ab	327 ab	69 a
13	Dual Magnum Linuron 4L	1 pt/a 12 oz/a	103 ab	123 ab	170 a	55 ab	7 bc	458 ab	358 ab	50 ab
14	Dual Magnum Linuron 4L	1 pt/a 24 oz/a	89 ab	102 ab	175 a	36 ab	7 abc	409 ab	323 ab	54 ab
15	Fierce*	1.5 oz/a	72 ab	101 ab	170 a	73 ab	21 ab	437 ab	371 ab	60 ab
16	Fierce*	2.25 oz/a	60 ab	89 ab	137 a	74 ab	30 a	390 ab	333 ab	62 ab

[a] **Within columns means followed by the same letter are not significantly different according to Tukey pairwise comparison (P ≤ 0.1).**

Linuron – Bottom Line

- 90% or greater weed control found with Chateau + metribuzin, metribuzin + Linuron, and Dual + Chateau + metribuzin.
- Linuron was an effective product with tank mixed with metribuzin.
- Chateau caused visible injury in most treatments.

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Timing of Linuron Tank Mixtures

Objective

- Determine the effects of linuron + metribuzin preemergence, at emergence, and postemergence on weed control and yield.

Procedures

- 3 sites years (2014-2015)
- Soils:
  - Loamy sand, pH 6.8, OM 1.4% (Ottertail, MN)
  - Sandy loam, pH 6.0, OM 2.3% (Inkster, ND)
  - Loamy sand, pH 6.1, OM 1.5% (Park Rapids, MN)

- Sprayer setup: nine-foot CO_2 backpack sprayer calibrated to deliver 15 gal/acre using XR11002 nozzles.

Procedures

- 3 sites years (2014-2015)
- Treatments
  - Preemergence (Linuron 12 or 24 oz/a (0.36 or 0.71 L/a) + 0.67 lb/a metribuzin)
  - 50-75% emergence (Linuron 12 or 24 oz/a + 0.67 lb/a metribuzin)
  - 4-6 inch tall plants (Linuron 12 or 24 oz/a + 0.67 lb/a metribuzin or 1.5 oz/a rimsulfuron)
  - 8-10 inch tall plants (Linuron 12 or 24 oz/a + 0.67 lb/a metribuzin)

Measurement

- Visual estimate of crop injury and weed efficacy
  - 14 and 28 DAT
- Graded yield

26 June 2014, Ottertail, MN

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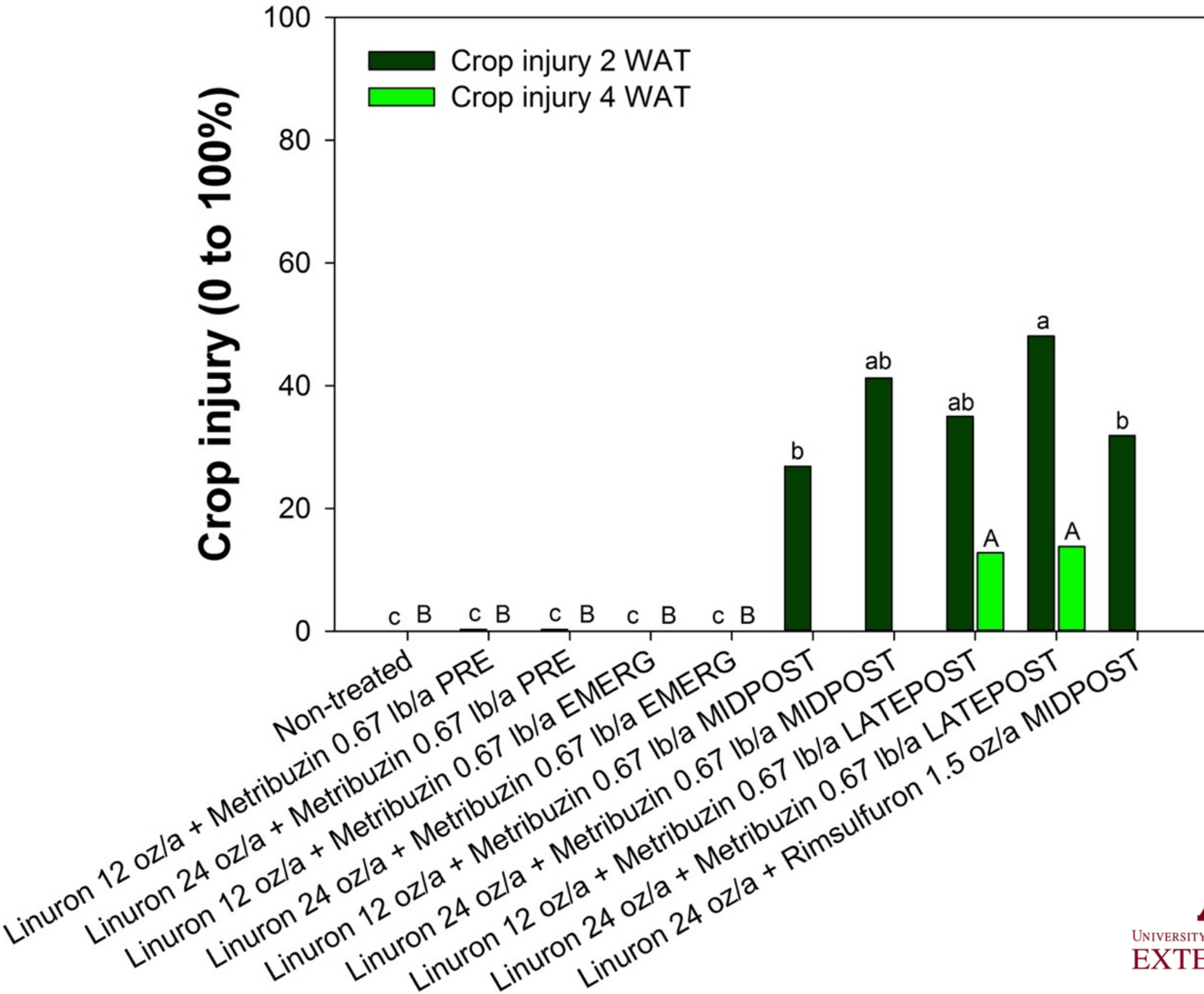

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Non-treated

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

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Chlorosis & Necrosis (2014)

Treatment	Rate	Timing	Chlorosis 14 DAT	Chlorosis 28 DAT	Necrosis 14 DAT	Necrosis 28 DAT
			%			
1 Non-treated			0 c	0	0 c	0 c
2 Linuron + Metribuzin	420 g/ha + 563 g/ha	PRE	0 c	0	0 c	0 c
3 Linuron + Metribuzin	420 g/ha + 563 g/ha	50% emergence	0 c	0	0 c	0 c
4 Linuron + Metribuzin	420 g/ha + 563 g/ha	8-10 in tall	9 b	0	40 b	11 a
5 Linuron + Metribuzin	840 g/ha + 563 g/ha	PRE	0 c	0	0 c	0 c
6 Linuron + Metribuzin	840 g/ha + 563 g/ha	50% emergence	0 c	0	0 c	0 c
7 Linuron + Metribuzin	840 g/ha + 563 g/ha	8-10 in tall	16 a	0	53 a	8 b

Chlorosis at 4 DAT

Linuron (840 g/ha) + Metribuzin (563 g/ha) at 50% Emergence
9 June 2014, Ottertail, MN

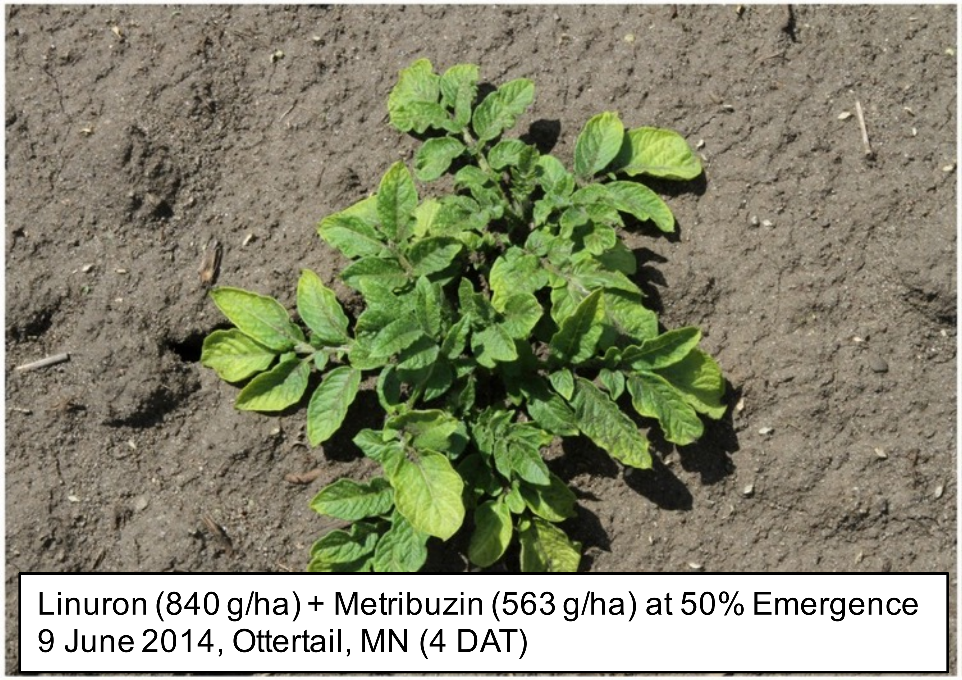
Chlorosis at 4 DAT

Chlorosis at 8 DAT

Linuron (840 g/ha) + Metribuzin (563 g/ha) at 50% Emergence
13 June 2014, Ottertail, MN

Chlorosis at 8 DAT

Linuron (420 g/ha) + Metribuzin (563 g/ha) at 50% Emergence
13 June 2014, Ottertail, MN



Linuron (840 g/ha) + Metribuzin (563 g/ha) at 50% Emergence
9 June 2014, Ottertail, MN (4 DAT)

Linuron (420 g/ha) + Metribuzin (563 g/ha) at 50% Emergence
13 June 2014, Ottertail, MN (8 DAT)


Metribuzin injury

Metribuzin Activity

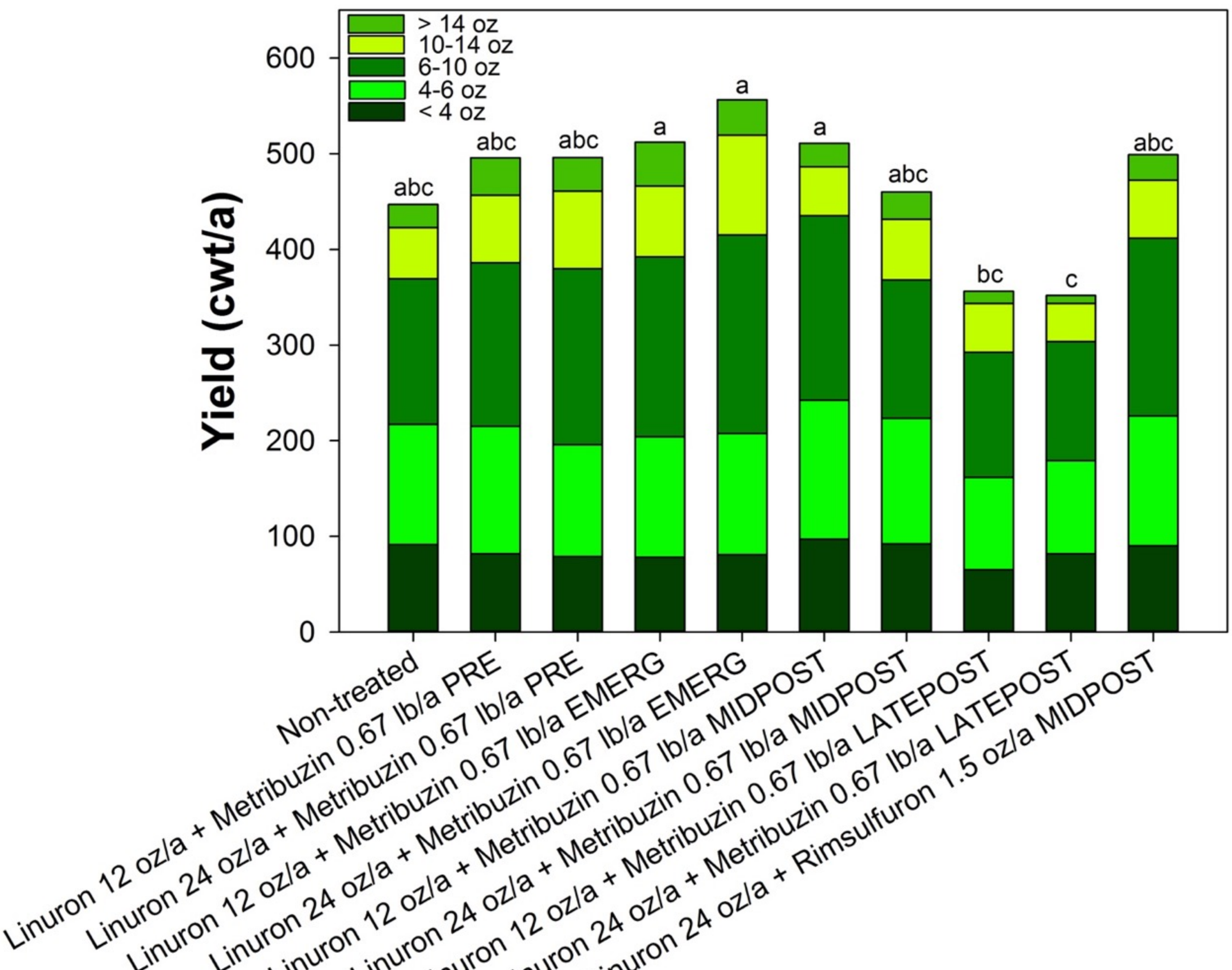
- More active in soils with:
  - Higher pH
  - Low organic matter
  - Stressed plants
- Symptoms can be severe when metribuzin is applied when plant metabolism is slowed, or within 3 days after periods of cool, wet, or cloudy weather.

5 DAT Linuron (840 g/ha) + Metribuzin (563 g/ha) at 8-10 inch tall
26 June 2014, Ottertail, MN

5 DAT Linuron (840 g/ha) + Metribuzin (563 g/ha) at 8-10 inch tall
26 June 2014, Ottertail, MN

Weed Control - 2014

Treatment		Rate	Timing	Wild proso millet 14 DAT	Wild proso millet 28 DAT
				%	%
1	Non-treated			0 c	0 c
2	Linuron + Metribuzin	420 g/ha + 563 g/ha	PRE	53 b	63 b
3	Linuron + Metribuzin	420 g/ha + 563 g/ha	50% emergence	100 a	100 a
4	Linuron + Metribuzin	420 g/ha + 563 g/ha	8-10 in tall	98 a	90 a
5	Linuron + Metribuzin	840 g/ha + 563 g/ha	PRE	99 a	100 a
6	Linuron + Metribuzin	840 g/ha + 563 g/ha	50% emergence	98 a	100 a
7	Linuron + Metribuzin	840 g/ha + 563 g/ha	8-10 in tall	88 a	96 a



> 14 oz
10-14 oz
6-10 oz
4-6 oz
< 4 oz
Yield (cwt/a)
0
100
200
300
400
500
600
abc
abc
abc
a
a
a
abc
bc
c
abc
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 12 oz/a + Metribuzin 0.67 lb/a LATEPOST
Linuron 24 oz/a + Metribuzin 0.67 lb/a LATEPOST
Linuron 24 oz/a + Rimsulfuron 1.5 oz/a MIDPOST

Yield Summary

- Total yield was similar at the preemergence, emergence, and 4-6 inch tall plant treatment timings.
- Total yield was reduced when linuron + metribuzin were applied to 8-10 inch tall plants.
- Marketable yield was similar to total yield. There was a numerical advantage when 24 oz/a of linuron + 0.67 lb/a metribuzin was applied at emergence.

Take Home Message

- Linuron mixed with metribuzin or rimsulfuron was a good preemergence herbicide option that did not effect potato yield or quality.

Questions?

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