Sugarbeet Tolerance and Weed Control from Postemergence Ethofumesate 4SC

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Ethofumesate – Historical Summary

- Ethofumesate was first registered as NORTRON (Edwards 2005)
  - Registered for annual grass and broadleaf control in sugarbeet
- Ethofumesate mode of action includes inhibition of mitosis along with reduced respiration and photosynthesis.
- Soil applied with some post-emergence activity (Eshel, 1978)
  - Up to 10 weeks residual control (Eshel et al., 1976, Elkins, 1972)
- Previous rates, ethofumesate has excellent control (90-99%) on redroot pigweed soil applied (ND Weed Control Guide, Zollinger et al. 2017)
  - Good to fair control (80-65%) on kochia, common lambsquarters, and waterhemp

Ethofumesate 4SC – New Label

- Regulatory Approval for Ethofumesate 4SC POST:
- Increase postemergence ethofumesate rate from 12 to 128 fl oz/A
- Decrease the Pre Harvest Interval (PHI) from 90 to 45 days
- Benefits - Unknown
  - Potential for greater control on later germinating weeds (Waterhemp)

http://www.willowoodusa.com/products/herbicides/willowood-usa-ethofumesate/

Technical challenges

- How does ethofumesate at rates up to 128 fl oz/A fit a weed management system in sugarbeet?
- Can sugarbeet tolerate ethofumesate postemergence?
- Is ethofumesate tank mixed more efficacious than applied alone postemergence?
- Can crops planted in sequence with sugarbeet tolerate these increased rates POST?

Weed Control

- Troublesome weed species in our growing area
  - Waterhemp (*Amaranthus tuberculatus*)
    - ALS inhibitor, Growth Regulator, EPSPS, PSII Inhibitor, PPO inhibitor, HPPD inhibitor
  - Common lambsquarters (*Chenopodium album*)
    - PSII Inhibitor, ALS inhibitor, EPSPS (suspected)
  - Redroot Pigweed (*Amaranthus retroflexus*)
    - ALS inhibitor, Atrazine (PSII)

Common Lambsquarters

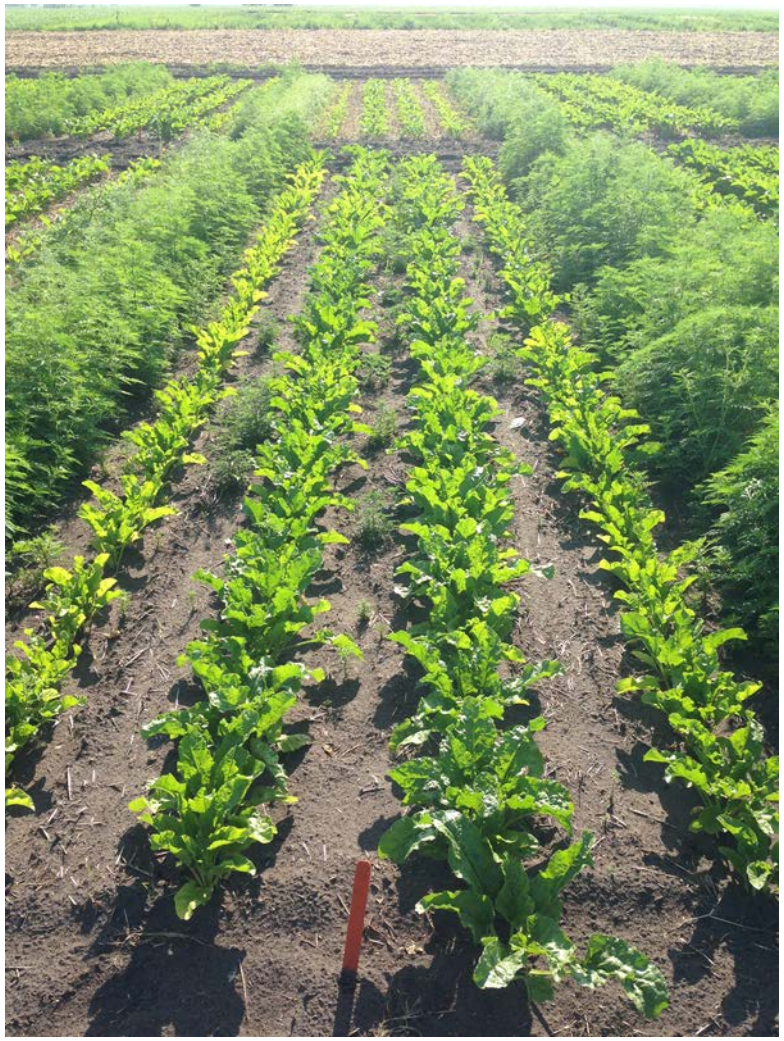
Redroot Pigweed

Waterhemp

Objectives

- Do sugarbeet tolerate Ethofumesate 4SC at rates to 128 fl oz/A?

- Does Ethofumesate 4SC POST control weeds?
  - Common Lambsquarters
  - Redroot Pigweed
  - Waterhemp



Materials and Methods

- Sugarbeet Tolerance
  - Experimental Design: Randomized Complete Block
  - Number of Locations: 6
  - Number of Replications: 6
  - Number of Treatments: 6

- Common lambsquarters, redroot pigweed, and waterhemp control
  - Experimental Design: Randomized Complete Block
  - Number of Locations: 2 per target weed
  - Number of Replications: 4
  - Number of Treatments: 13

Field Evaluations

- Sugarbeet Injury
  - Visual (0-100%)
- Sugarbeet Stand
  - 10’ of middle 2/4 treated rows counted
- Yield
  - Tons per acre
  - % Sucrose
  - Recoverable sucrose per acre
- Weed Control
  - Visual (0-100%)
- Weed Density
  - 1/4 meter quadrats

Do Sugarbeet Tolerate Ethofumesate 4SC? – Density and Stature Reduction[a]

Ethofumesate[b]	Density	7 DAT[c]	14 DAT	28 DAT
--fl oz/A--	---100 ft---	----------%----------		
0	150	0 a	0 a	0 a
8	149	2 a	1 a	0 a
16	151	2 a	2 a	1 a
32	150	7 b	6 b	2 a
64	153	16 c	14 c	8 b
128	147	28 d	29 d	18 c
LSD (0.05)	NS	5	5	4
	----------*p*-value----------			
	0.4305	<0.0001	<0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the t-test at the 5% level of significance.
[b]High surfactant methylated oil concentrate at 1.8 L ha^{-1} added to each post treatment.
[c]Stature reduction 7 and 14 days after treatment (DAT).

Does Sugarbeet Tolerate Ethofumesate 4SC? – Yield Components[a]

Ethofumesate[b]	Root Yield[c]	Sucrose Content	Rec. Suc[d]
--fl oz/A--	---Tons/A---	---%---	---lbs/A---
0	30	15.7	8,484 ab
8	30	15.6	8,343 abc
16	30	15.7	8,440 ab
32	31	15.7	8,511 a
64	29	15.7	8,143 bc
128	29	15.4	8,024 c
LSD (0.05)	NS	NS	349
	----------*p*-value----------		
	0.1418	0.2844	0.0410

[a]Means within a main effect not sharing any letter are significantly different by the t-test at the 5% level of significance.
[b]High surfactant methylated oil concentrate at 1.5 pt/A added to each post treatment.
[c]Root yield reported in tons per acre.
[d]Recoverable sucrose reported in pounds per acre.

Does Sugarbeet Tolerate Ethofumesate 4SC? – Yield Components[a]

Ethofumesate[b]	Root Yield[c]	Sucrose Content	Rec. Suc[d]
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128 fl oz/A

64 fl oz/A

32 fl oz/A

Untreated check

Hickson, ND
2019

128 fl oz/A

64 fl oz/A

32 fl oz/A

Untreated Check

Prosper, ND
2018

Sugarbeet visible stature reduction in response to herbicide application across environments[a]

Treatment	Rate	Stature Reduction	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate [b]	32	2 a	1 a
Ethofumesate [c]	16	3 a	3 ab
Ethofumesate [c]	32	8 ab	5 abc
Ethofumesate [c]	64	17 cd	18 d
Ethofumesate [c]	128	25 def	28 e
Ethofumesate + glyphosate [d]	32 + 32	14 bc	8 bc
Ethofumesate + glyphosate [d]	64 + 32	22 cdef	19 d
LSD (0.05)		8	5
		----------*P*-value----------	
		<0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.
[b]Ammonium sulfate at 2.5% v/v and non-ionic surfactant at 0.25% v/v.
[c]High surfactant methylated oil concentrate at 1.5 pt/A.
[d]Ammonium sulfate at 2.5% v/v and high surfactant methylated oil concentrate at 1.5 pt/A.

Sugarbeet visible stature reduction in response to herbicide application across environments[a]

Treatment	Rate	Stature Reduction	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate [b]	32	2 a	1 a
Ethofumesate [c]	16	3 a	3 ab
Ethofumesate [c]	32	8 ab	5 abc
Ethofumesate [c]	64	17 cd	18 d
Ethofumesate [c]	128	25 def	28 e
Ethofumesate + glyphosate [d]	32 + 32	14 bc	8 bc
Ethofumesate + glyphosate [d]	64 + 32	22 cdef	19 d
LSD (0.05)		8	5
		----------*P*-value----------	
		<0.0001	<0.0001

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[b]Ammonium sulfate at 2.5% v/v and non-ionic surfactant at 0.25% v/v.
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[d]Ammonium sulfate at 2.5% v/v and high surfactant methylated oil concentrate at 1.5 pt/A.


Ethofumesate at 128 fl oz/A

Common lambsquarters control, 7 and 14 DAT, across environments[a]

Treatment	Rate	Common Lambsquarters	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate	32	98 a	95 a
Ethofumesate	16	48 e	45 e
Ethofumesate	32	70 cd	66 d
Ethofumesate	64	64 d	77 bcd
Ethofumesate	128	79 bc	84 abc
Ethofumesate + glyphosate	32 + 32	100 a	96 a
Ethofumesate + glyphosate	64 + 32	100 a	95 a
LSD (0.05)		13	16
		----------*P*-value----------	
		<0.0001	<0.0001

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	---fl oz/A---	----------%----------	
Glyphosate	32	98 a	95 a
Ethofumesate	16	48 e	45 e
Ethofumesate	32	70 cd	66 d
Ethofumesate	64	64 d	77 bcd
Ethofumesate	128	79 bc	84 abc
Ethofumesate + glyphosate	32 + 32	100 a	96 a
Ethofumesate + glyphosate	64 + 32	100 a	95 a
LSD (0.05)		13	16
		----------*P*-value----------	
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Redroot pigweed visible control 7 and 14 DAT across environments[a]

Treatment	Rate	Redroot Pigweed	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate	32	99 a	93 ab
Ethofumesate	16	44 fg	47 e
Ethofumesate	32	50 ef	62 d
Ethofumesate	64	54 def	71 cd
Ethofumesate	128	64 cd	76 cd
Ethofumesate + glyphosate	32 + 32	99 a	98 a
Ethofumesate + glyphosate	64 + 32	100 a	99 a
LSD (0.05)		10	14
		----------*P*-value----------	
		<0.0001	<0.0001

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Redroot pigweed visible control 7 and 14 DAT across environments[a]

Treatment	Rate	Redroot Pigweed	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate	32	99 a	93 ab
Ethofumesate	16	44 fg	47 e
Ethofumesate	32	50 ef	62 d
Ethofumesate	64	54 def	71 cd
Ethofumesate	128	64 cd	76 cd
Ethofumesate + glyphosate	32 + 32	99 a	98 a
Ethofumesate + glyphosate	64 + 32	100 a	99 a
LSD (0.05)		10	14
		----------*P*-value----------	
		<0.0001	<0.0001

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.

Waterhemp visible control 7 and 14 DAT across environments[a]

Treatment	Rate	Waterhemp	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate	32	62 bcd	53 cd
Ethofumesate	16	58 cd	65 bcd
Ethofumesate	32	63 bcd	66 bc
Ethofumesate	64	74 abc	78 ab
Ethofumesate	128	80 ab	84 a
Ethofumesate + glyphosate	32 + 32	86 a	86 a
Ethofumesate + glyphosate	64 + 32	91 a	91 a
LSD (0.05)		18	16
ANOVA		----------*P*-value----------	
		0.0001	<0.0001

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Waterhemp visible control 7 and 14 DAT across environments[a]

Treatment	Rate	Waterhemp	
		7 DAT	14 DAT
	---fl oz/A---	----------%----------	
Glyphosate	32	62 bcd	53 cd
Ethofumesate	16	58 cd	65 bcd
Ethofumesate	32	63 bcd	66 bc
Ethofumesate	64	74 abc	78 ab
Ethofumesate	128	80 ab	84 a
Ethofumesate + glyphosate	32 + 32	86 a	86 a
Ethofumesate + glyphosate	64 + 32	91 a	91 a
LSD (0.05)		18	16
ANOVA		----------*P*-value----------	
		0.0001	<0.0001

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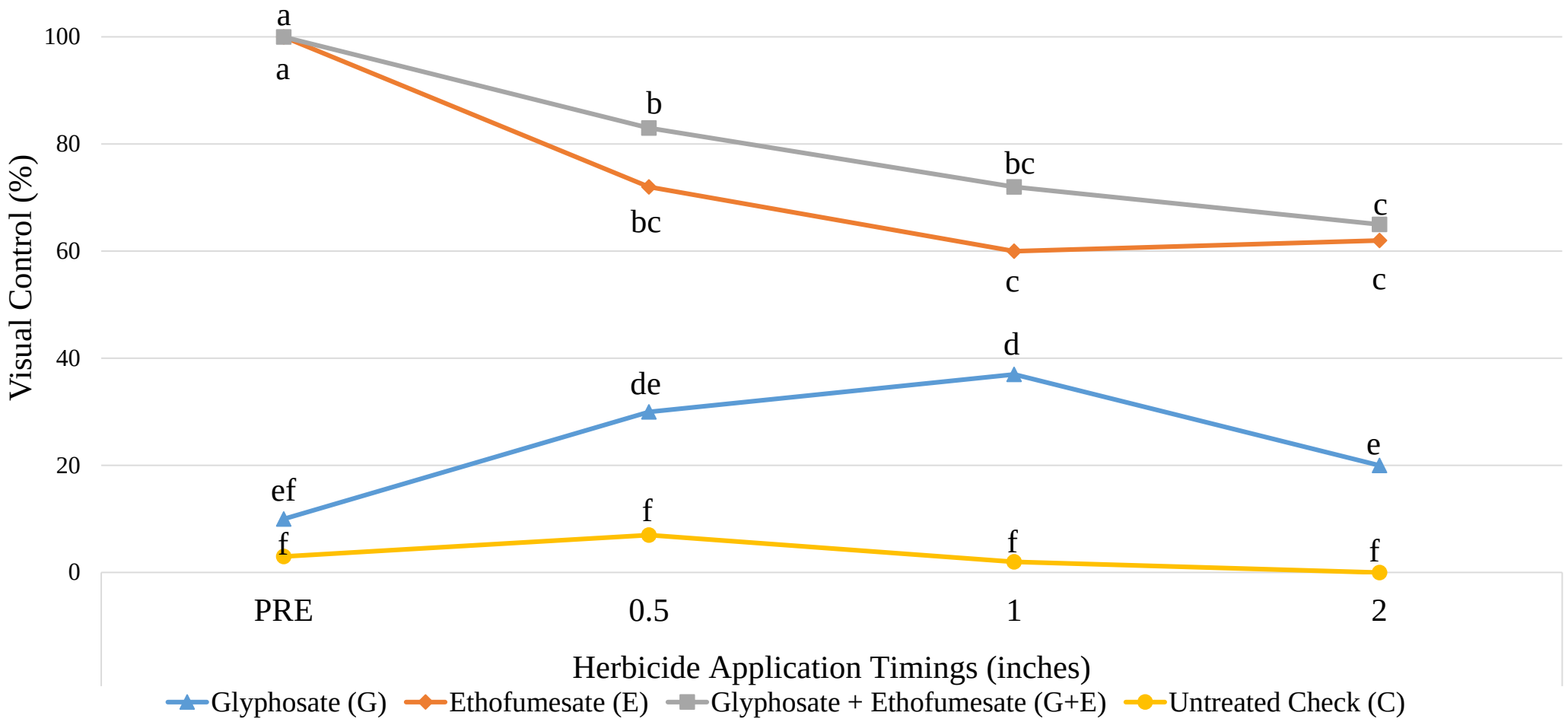
Waterhemp control 14 DAT in response to herbicide treatment and application timing, greenhouse, 2019[a]



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Sugarbeet Tolerance Summary

- Ethofumesate 4SC postemergence at rates to 128 fl oz/A did not reduce sugarbeet stand, root yield, or sucrose content.
- Ethofumesate 4SC at 128 fl oz/A reduced recoverable sucrose content
- Ethofumesate 4SC reduced sugarbeet stature at 64 and 128 fl oz/A
  - Sugarbeet recovered from stature reduction

Efficacy Summary

- Ethofumesate is not a stand-alone POST herbicide for common lambsquarters, redroot pigweed, or waterhemp control
- Glyphosate alone or ethofumesate plus glyphosate at 32 + 32 fl oz/A, provided the greatest overall control of common lambsquarters and redroot pigweed
- Ethofumesate plus glyphosate at 32 fl oz/A or ethofumesate at 128 fl oz/A provided the greatest waterhemp control
  - Ethofumesate 4SC at 128 fl oz/A significantly increases sugarbeet stature reduction and input costs compared to glyphosate + ethofumesate at 32 fl oz/A

Acknowledgements

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Thank you

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