

IMPACT OF FLUXOFENIM SEED SAFENER ON SUGAR BEET RESPONSE TO GROUP 15 HERBICIDES APPLIED PREEMERGENCE

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INTRODUCTION

Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*Amaranthus tuberculatus*) populations with resistance to glyphosate have recently been confirmed in sugar beet (*Beta vulgaris*) production areas in the Pacific Northwest (PNW)¹. Currently, there are no effective postemergence herbicides for controlling glyphosate-resistant Palmer amaranth and waterhemp in sugar beets. Although acetochlor, dimethenamid-p and s-metolachlor are very effective for controlling Palmer amaranth and waterhemp in sugar beet, they are only labeled for application after sugar beet reaches the two-leaf stages.

OBJECTIVES AND HYPOTHESES

1. Evaluate sugar beet response to preemergence applications of acetochlor, dimethenamid-p and s-metolachlor.
2. Assess the effectiveness of fluxofenim as a safener for protecting sugar beet from the preemergence application of acetochlor, dimethenamid-p and s-metolachlor.

H: Acetochlor, dimethenamid-p, and s-metolachlor are safe when applied preemergence to sugar beet.

H: Fluxofenim seed treatment will act as a safener to protect sugar beet from the preemergence application of acetochlor, dimethenamid-p, and s-metolachlor.

METHODOLOGY

Field experiments were conducted in 2024 and 2025 at Kimberly, Idaho; and Nyssa and Ontario, Oregon (Figure 1).

Experiment details



Variety: BTS 2024, glyphosate tolerant

Plots dimension: 2.2 m wide and 7.6 m long

Irrigation:

Kimberly and Nyssa: Sprinkler

Ontario: Furrow

Herbicide application:

Preemergence: within 48 h after planting and immediately irrigated with 2.5 cm of water.

Postemergence: Glyphosate at 2-leaf and 8 to 10 leaf stages of sugar beet.

Figure 1. Established experiment at harvest in Kimberly, ID.

➤ Split-plot randomized complete block with 4 replicates:

- **Main plot (fluxofenim seed treatment):** Sugar beet seed treated with fluxofenim (Concep® III) at 0.4 g of fluxofenim/kg of seed vs no seed treatment (Figure 2).

- **Subplot (herbicides):** Ten herbicide treatments (Table 1).

Table 1. Herbicide treatment description.

Herbicide	rate (g ai or ae /ha)
1. s-metolachlor	534
2. s-metolachlor	1070
3. dimethenamid-P	840
4. dimethenamid-P	1100
5. acetochlor	1050
6. acetochlor	1680
7. s-metolachlor + ethofumesate	534 + 1120
8. dimethenamid-P + ethofumesate	840 + 1120
9. acetochlor + ethofumesate	1050 + 1120
10. glyphosate (check) at 2-leaf	1260



Figure 2: Sugar beet seed treatment and coating process.

Data collection and Statistical Analysis

➤ Visual control (0-100%), stand count (plant/ha) at 28 and 42 days after planting (DAP). Root yield (MT/ha) and sugar concentration (%) at harvest (September).

➤ Data were subject to mixed-effects ANOVA with a 'lme4' package in R statistical software. Herbicide and seed treatment were fixed effects and year was a random effect. Means were separated using Tukey's HSD ($\alpha = 0.05$).

RESULTS

Table 2. Sugar beet visible injury at 28 and 42 days after planting (DAP) in response to preemergence application of herbicides to sugar beet with or without fluxofenim safener at 3 locations in 2024 and 2025.

Treatment	Visible injury (%)					
	Kimberly		Nyssa		Ontario	
	28 DAP	42 DAP	28 DAP	42 DAP	28 DAP	42 DAP
Safener						
None	17B	15	20	23	22	10A
Fluxofenim (0.4 g/kg of seed)	21A	18	20	19	20	8B
P-value	0.03	0.06	0.91	0.24	0.07	0.004
Herbicide						
S-metolachlor (534 g ae/ha)	12C	10C	8DE	10DE	16D	1F
S-metolachlor (534 g ae/ha) + Ethofumesate (1120 g ae/ha)	18C	15C	20BC	21A-D	14DE	8E
S-metolachlor (1070 g ae/ha)	20BC	18BC	20BC	17CD	18D	1F
Dimethenamid-p (840 g ae/ha)	29AB	28A	29AB	32AB	9E	1F
Dimethenamid-p (840 g ae/ha) + Ethofumesate (1120 g ae/ha)	31A	25AB	24A-C	25A-C	15DE	8DE
Dimethenamid-p (1100 g ae/ha)	29AB	28A	33A	34A	26C	12CD
Glyphosate (1260 g ae/ha)	0D	0D	4E	4E	0F	0F
Acetochlor (1050 g ae/ha)	18C	14C	16C-E	23A-D	28C	14BC
Acetochlor (1050 g ae/ha) + Ethofumesate (1120 g ae/ha)	19C	14C	18B-D	18B-D	38B	17B
Acetochlor (1680 g ae/ha)	15C	13C	27A-C	26A-C	48A	30A
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Interaction	0.57	0.53	0.05	0.76	<0.001	<0.001

Table 4. Sugar beet root yield and sugar concentration at harvest in response to preemergence application of herbicides to sugar beet with or without fluxofenim safener at 3 locations in 2024 and 2025.

Treatment	Kimberly	Nyssa	Ontario	Kimberly	Nyssa	Ontario
	— Root yield (MT/ha) —			— Sugar (%) —		
Safener						
None	111.15	106.21	111.15	16.3	14.9	15.5
Fluxofenim (0.4 g /kg of seed)	113.62	108.68	108.68	16.6	15	15.6
P-value	0.18	0.2	0.43	0.44	0.62	0.8
Herbicide						
S-metolachlor (534 g ae/ha)	113.62	108.68	116.09	16.2	14.9	15.7AB
S-metolachlor (534 g ae/ha) + Ethofumesate (1120 g ae/ha)	113.62	108.68	113.62	16.2	15.1	15.6AB
S-metolachlor (1070 g ae/ha)	113.62	108.68	111.15	16.4	14.9	15.5AB
Dimethenamid-p (840 g ae/ha)	106.21	106.21	111.15	16.2	14.9	15.8A
Dimethenamid-p (840 g ae/ha) + Ethofumesate (1120 g ae/ha)	108.68	103.74	106.21	16.3	14.9	15.3B
Dimethenamid-p (1100 g ae/ha)	108.68	103.74	111.15	16	14.9	15.4AB
Glyphosate (1260 g ae/ha)	116.09	108.68	103.74	18.5	14.9	15.4AB
Acetochlor (1050 g ae/ha)	116.09	108.68	103.74	16.3	15.1	15.6AB
Acetochlor (1050 g ae/ha) + Ethofumesate (1120 g ae/ha)	113.62	111.15	113.62	16.3	14.9	15.6AB
Acetochlor (1680 g ae/ha)	113.62	106.21	106.21	16.3	15.1	15.6AB
P-value	0.13	0.22	0.03	0.43	0.52	0.03
Interaction	0.18	0.1	0.71	0.49	0.51	0.02

Table 3. Sugar beet stand density at 28 and 42 DAP in response to preemergence application of herbicides to sugar beet with or without fluxofenim safener at 3 locations in 2024 and 2025.

Treatment	Stand count (plants/ha)					
	Kimberly		Nyssa		Ontario	
	28 DAP	42 DAP	28 DAP	42 DAP	28 DAP	42 DAP
Safener						
None	118064	122384A	141247	138797	108112	107242
Fluxofenim (0.4 g /kg of seed)	110387	113585B	141193	140089	110031	108890
P-value	0.1	0.03	0.98	0.73	0.5	0.55
Herbicide						
S-metolachlor (534 g ae/ha)	124957A	128161A	153222A	150714A	111459	110725
S-metolachlor (534 g ae/ha) + Ethofumesate (1120 g ae/ha)	123179A	125343A	142554AB	139562AB	112007	111335
S-metolachlor (1070 g ae/ha)	113109A-C	115794A-C	149576A	147239A	107363	105407
Dimethenamid-p (840 g ae/ha)	94594C	99371C	121546D	122433C	103698	103698
Dimethenamid-p (840 g ae/ha) + Ethofumesate (1120 g ae/ha)	105094A-C	105071BC	133523B-D	132199BC	109374	107376
Dimethenamid-p (1100 g ae/ha)	100028BC	102377C	128260CD	100028C	106813	105775
Glyphosate (1260 g ae/ha)	124224A	127941A	153590A	124224A	110710	108393
Acetochlor (1050 g ae/ha)	120212A	128872A	142373A-C	120212AB	108280	108342
Acetochlor (1050 g ae/ha) + Ethofumesate (1120 g ae/ha)	119494AB	122917AB	143742AB	119494AB	109441	108463
Acetochlor (1680 g ae/ha)	117367AB	124001A	143816AB	117367AB	111577	111150
P-value	<0.001	<0.001	<0.001	<0.001	0.31	0.21
Interaction	0.73	0.5	0.03	0.04	0.35	0.53

glyphosate
(1260g ae/ha)

dimethenamid-p
(1102g ai/ha)



Figure 3. Sugar beet response at 42 DAP to preemergence application of dimethenamid-p compared with the glyphosate check at the Kimberly site.

DISCUSSION

➤ Visible sugar beet injury of 34% or less was observed all sites (Table 2) and (Figure 3).

➤ Dimethenamid-p caused the greatest visible injury at Kimberly and Nyssa while acetochlor caused more injury at the Ontario site (Table 2 & Figure 3).

➤ Fluxofenim reduced visual injury by approximately 2% at the Ontario site (Table 2).

➤ Only dimethenamid-p significantly reduced sugar beet stand density at Kimberly and Nyssa sites (Table 3 & Figure 3).

➤ Fluxofenim did not improve stand density at any location (Table 3) and (Figure 3).

➤ No significant root yield or sugar concentration reductions were observed (Table 4).

CONCLUSION AND FUTURE DIRECTIONS

➤ Acetochlor, dimethenamid-p and s-metolachlor were safe when applied preemergence to sugar beet.

➤ Fluxofenim had a minimal effect on the safety of acetochlor, dimethenamid-p and s-metolachlor to sugar beet.

➤ These results can be used to pursue possible special local needs 24(c) registration of acetochlor and s-metolachlor for preemergence weed control in sugar beet.

REFERENCES

1. Adjesiwor, A.T., Liu, R., Felix, J. and Alder, C. (2024), Palmer Amaranth in the Pacific Northwest. Crops & Soils Magazine. <https://doi.org/10.1002/crso.20363>.

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