Broadleaf Weed Control with Pulse-Width Modulation (PWM) Technology

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Justification

- Many broadleaf weeds exhibit resistance to multiple herbicide sites of action

- Recent introduction of Palmer Amaranth into ND leads to an increased need for effective pigweed species management

- Pressure based spray systems are inconsistent at varying speed

- Research conducted at NDSU in previous growing seasons indicate travel speed and droplet size having a negative effect on control when using a PWM system

Pigweed Species Infestation

- Main area for weed science research
- Mix of pigweed and waterhemp
- Mowed down every two weeks
  - Grew back almost as tall every time

Fargo, ND, 7/18/16

Pulse-Width Modulation sprayer

- Uses a "duty cycle"
  - Pulsing solenoid with nozzle body
  - Time open/total time = % duty
- As speed increases, duty cycle increases, and vice versa
- Also accommodates for some unwanted horizontal boom movement
  - Think boom jolting forward or backward
- $$$$$

Objectives

- Determine the efficacy of postemergence herbicides to control common ragweed, waterhemp, and common lambsquarters
- Determine enhancement of various herbicide programs when applied with pulse-width modulation technology
- Evaluate droplet size and variable rates of speed and how they affect weed control

Field trials

- Conducted near Fargo, Galesburg, and Prosper ND.
  - '18 and '19 growing seasons
  - Randomized Complete Block Design (RCBD)
  - 3 replicates
  - Plots 15 x 30 ft
- Factorial combination of treatments included within RCBD
  - Four different VMDs
  - Three different speeds
  - Handboom sprayed check
  - Untreated check
- Visual control rating taken at 14 and 28 days after treatment
- Stand counts taken before treatment and after the 28dat rating
- Biomass collected after 28dat rating
  - Fresh weight and dry weight were recorded

Field Trials cont.

- Four trials per growing season, per location
  - Two trials in Wheat
    - Emulating Affinty and Huskie systems
  - Two trials in Soybean
    - Emulating Liberty Link and Xtendimax systems
- Polaris Ranger equipped with Capstan PWM spray system
  - Boom width 12 ft
  - Wilger Nozzle tips
    - Targeting VMDs 250, 400, 600, 750 μm
- Handboom
  - Boom width 7 ft
  - Turbo Teejet 110˚ Flat Fan based on label recommendations

Herbicide list for field trials

Herbicide	Rate			Trade Name	Manufacturer	Trial
	g ai ha-1	g ha-1	L ha-1			
Glyphosate	840			Roundup PowerMAX	Bayer	a
Dicamba	560			Xtendimax	Bayer	a
Glufosinate	630			Liberty 280 SL	BASF	b
Fomesafen	200			Flexstar	Syngenta	b
AMS		3360		generic	West Central	b
MSO			1.2	Superspread MSO	West Central	b
Bromoxynil&pyrasulfotole	840			Huskie	Bayer	c
2,4-d	560			2,4-d	Nufarm	d
Thifensulfuron	630			Harmony SG	FMC	d
Tribenuron	200			Express SG	FMC	d
NIS			0.2	generic	West Central	d
Fenoxaprop				Tacoma	Winfield	d

Xtend treatment means

Treatment	Equipment	Droplet size	Travel speed	CHEAL[a]	CHEAL F18[b]	AMARE	AMARE F18	AMBEL
		µm	mph		treatment means			
1	Handboom	290	3	97.8	99.0	98.3	99.0	99.0
2	PWM	250	5	98.5	99.0	98.5	99.0	98.3
3	PWM	250	10	96.8	76.0	97.5	82.7	97.3
4	PWM	250	15	96.7	99.0	96.8	99.0	94.2
5	PWM	400	5	98.7	99.0	97.8	99.0	98.7
6	PWM	400	10	98.2	99.0	96.1	99.0	97.3
7	PWM	400	15	97.2	99.0	97.0	99.0	99.0
8	PWM	600	5	97.7	98.3	99.0	99.0	99.0
9	PWM	600	10	97.7	99.0	98.1	99.0	98.7
10	PWM	600	15	89.3	99.0	94.2	99.0	98.3
11	PWM	750	5	97.2	99.0	96.7	99.0	99.0
12	PWM	750	10	98.2	99.0	98.1	99.0	98.3
13	PWM	750	15	96.6	97.7	98.0	99.0	98.7
LSD				ns	ns	ns	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.
[b]Location, Fargo ND, 2018

Xtend: droplet size X travel speed

Factor	Droplet size μm	Speed mph	CHEAL[a] 28 DAT	AMARE 28 DAT	AMBEL 28 DAT
A	250		97.3	97.6	96.6
	400		98.0	96.9	98.3
	600		94.9	97.1	98.7
	750		97.3	97.6	98.7
CV					
LSD α=0.05			ns	ns	ns
B		5	98.0	98.0	98.8
		10	97.7	97.4	97.9
		15	94.9	96.5	97.5
CV					
LSD α=0.05			ns	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.

Liberty treatment means

Treatment	Equipment	Droplet size	Travel speed	CHEAL[a]	CHEAL G19[b]	AMARE	AMBEL
		μm	mph		treatment means		
1	Handboom	290	3	90.3 bc	99.0 a	97.7 a	98.7
2	PWM	250	5	96.4 a	99.0 a	97.6 a	99.0
3	PWM	250	10	96.9 a	99.0 a	98.0 a	99.0
4	PWM	250	15	95.2 ab	98.3 a	97.4 a	99.0
5	PWM	400	5	96.2 a	99.0 a	98.2 a	98.7
6	PWM	400	10	92.8 abc	99.0 a	96.7 ab	97.7
7	PWM	400	15	93.6 ab	97.0 a	94.5 bc	98.3
8	PWM	600	5	94.3 ab	99.0 a	97.9 a	99.0
9	PWM	600	10	95.5 bc	99.0 a	98.0 a	99.0
10	PWM	600	15	92.6 abc	98.3 a	97.5 a	97.0
11	PWM	750	5	94.7 ab	99.0 a	98.0 a	99.0
12	PWM	750	10	88.3 dc	97.7 a	97.0 ab	98.0
13	PWM	750	15	85.0 d	93.0 b	92.1 c	98.0
LSD				5.1	2.5	2.7	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.
[b]Location, Galesburg ND, 2019

Liberty: droplet size X travel speed

Factor	Droplet size µm	Speed mph	CHEAL[a] 28 DAT	AMARE 28 DAT	AMBEL 28 DAT
A	250		96.7 a	97.7	99.0
	400		95.0 a	96.5	98.2
	600		95.0 a	97.8	98.3
	750		90.8 b	95.7	98.3
CV			2.0		
LSD α=0.05			2.3	ns	ns
B		5	96.1 a	97.9	98.9
		10	94.4 ab	97.4	98.4
		15	92.6 b	95.4	98.1
CV			2.0		
LSD α=0.05			2.0	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.

Handboom-sprayed check

Untreated check

250μm, 10 mph

400μm, 10 mph

750μm, 15 mph

Untreated check

Huskie treatment means

Treatment	Equipment	Droplet size	Travel speed	CHEAL[a]	CHEAL F18[b]	HP	AMARE P19[c]	HR
		µm	mph		treatment means			
1	Handboom	290	3	81.4a	94.7	96.4	79.0	93.2
2	PWM	250	5	81.7a	97.7	94.7	50.0	88.0
3	PWM	250	10	67.7abc	96.3	93.2	46.7	87.3
4	PWM	250	15	70.6abc	93.7	90.4	73.3	92.8
5	PWM	400	5	77.9ab	91.3	91.4	53.3	92.7
6	PWM	400	10	73.6abc	95.7	96.8	70.0	87.2
7	PWM	400	15	72.0abc	90.7	95.6	74.0	94.8
8	PWM	600	5	79.5a	93.3	92.2	91.7	91.5
9	PWM	600	10	58.9c	94.7	94.3	65.0	90.8
10	PWM	600	15	76.8ab	96.3	92.2	66.3	90.8
11	PWM	750	5	62.3bc	92.7	93.4	64.7	83.8
12	PWM	750	10	65.7abc	94.3	92.8	89.0	82.2
13	PWM	750	15	62.9bc	94.0	96.2	74.7	88.3
LSD				16.217	ns	ns	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.
[b]Location, Fargo ND, 2018
[c]Location, Prosper ND, 2019
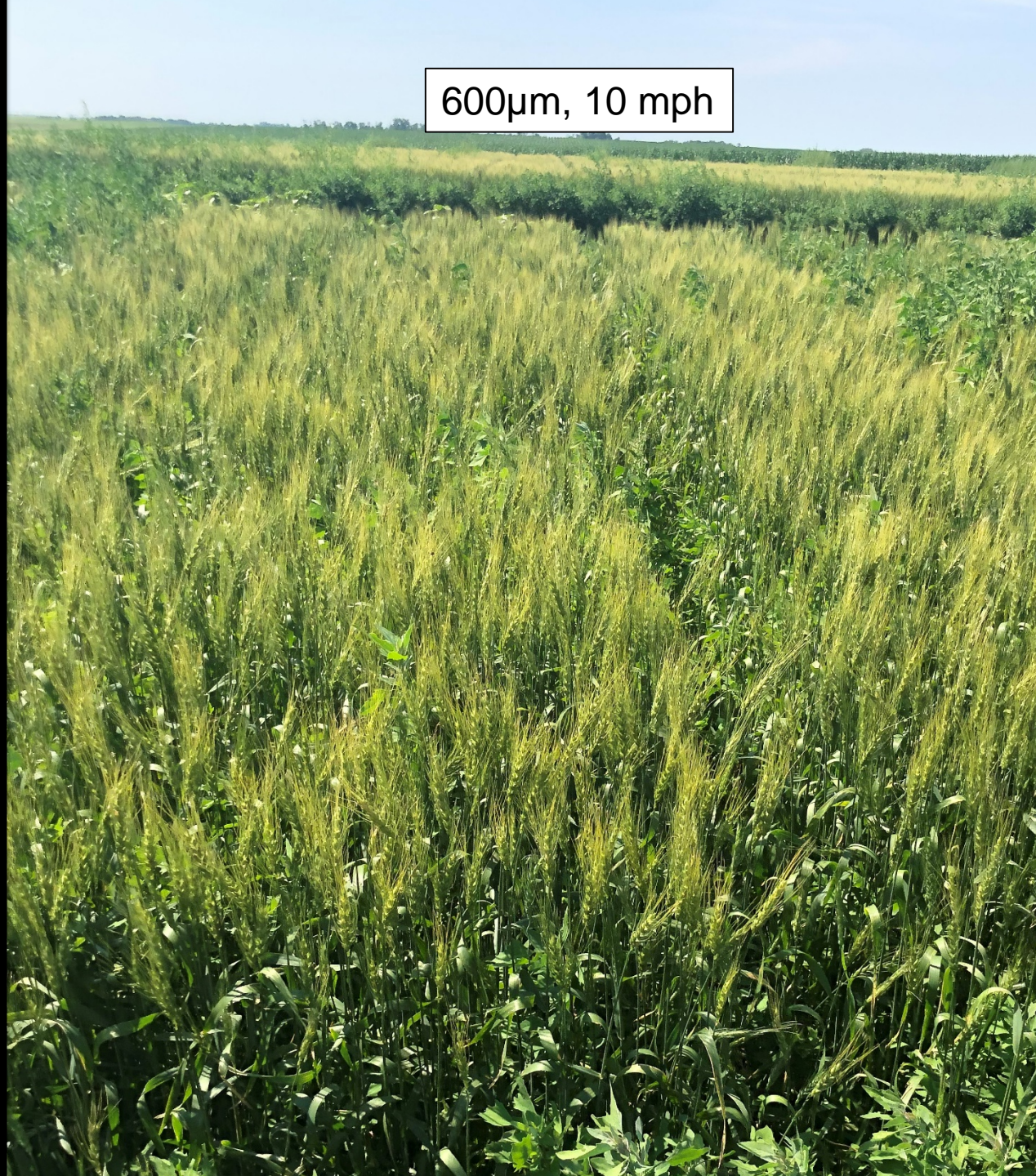
Huskie: droplet size X travel speed

Factor	Droplet size μm	Speed mph	CHEAL[a] 28 DAT	AMARE 28 DAT	AMBEL 28 DAT
A	250		73.3ab	89.7	89.4
	400		74.5ab	92.4	91.6
	600		71.7ab	89.9	91.1
	750		63.6b	91.7	84.8
CV			2.0		
LSD α=0.05			9.7	ns	ns
B		5	75.4	89.9	89.0
		10	66.5	91.9	86.9
		15	70.6	90.9	91.7
CV					
LSD α=0.05			ns	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.

Handboom

600μm, 10 mph

Affinity treatment means

Treatment	Equipment	Droplet size	Travel speed	CHEAL[a]	AMARE	AMBEL
		μm	mph		treatments means	
1	Handboom	290	3	96.4	97.0	84.2
2	PWM	250	5	97.8	96.3	70.0
3	PWM	250	10	95.4	93.8	70.7
4	PWM	250	15	96.7	97.3	84.0
5	PWM	400	5	96.5	97.2	85.2
6	PWM	400	10	96.8	93.1	79.8
7	PWM	400	15	94.3	96.9	72.5
8	PWM	600	5	95.9	96.2	72.0
9	PWM	600	10	95.2	95.4	71.7
10	PWM	600	15	96.0	96.6	79.0
11	PWM	750	5	96.3	97.0	80.3
12	PWM	750	10	94.8	94.8	75.0
13	PWM	750	15	97.2	94.3	76.2
LSD				ns	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.
[b]Location, Fargo ND, 2018

Affinity: droplet size X travel speed

Factor	Droplet size µm	Speed mph	CHEAL[a] 28 DAT	AMARE 28 DAT	AMBEL 28 DAT
A	250		94.3	94.2	74.9
	400		92.7	94.1	79.2
	600		92.4	94.6	74.2
	750		93.2	93.6	77.2
CV					
LSD α=0.05			ns	ns	ns
B		5	94.3	95.5	76.9
		10	92.0	91.9	74.3
		15	93.1	94.9	77.9
CV					
LSD α=0.05			ns	ns	ns

[a]Bayer Code: CHEAL, common lambsquarters; AMARE, redroot pigweed; AMBEL, common ragweed.

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