

Effectiveness of PRE Herbicides followed by Zidua POST for Controlling Glyphosate-Resistant Weeds in High Plains Sunflower Production

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Cultivated Sunflower and Weeds



- Total 1.38 million acres in 2019
- Major production in ND, SD, CO, KS, CA, MN, TX, NE
- Weed interference is a major production challenge for sunflower
- Limited herbicide options make weed control difficult

Two Key Weeds in High Plains Sunflower Production



Palmer amaranth

Distribution of Glyphosate-Resistance Kochia

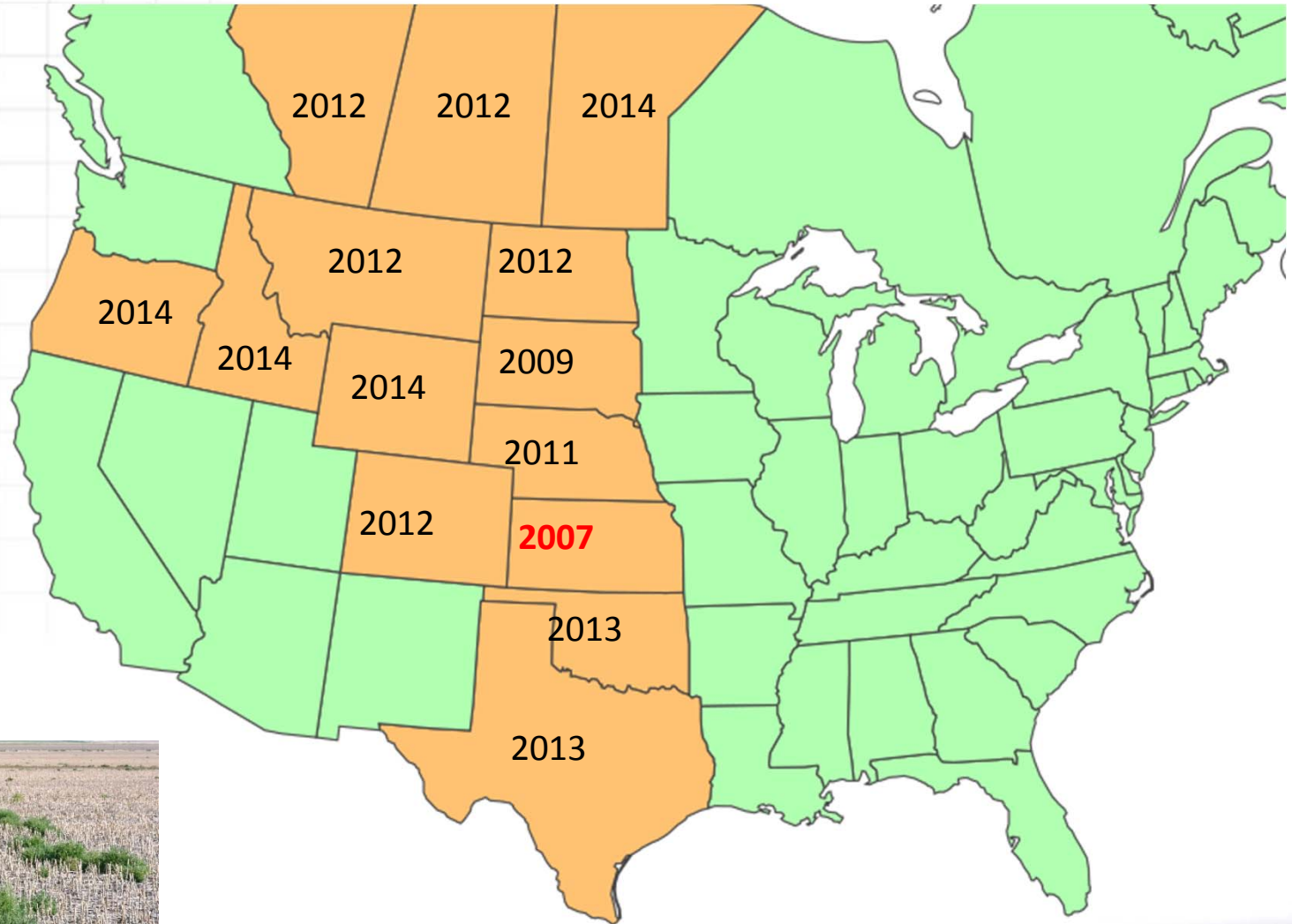


Photo: Phil Stahlman, KSU

Two Cases of Multiple SOA in Kansas

❖ Kochia (*Bassia scoparia*)

- glyphosate (group 9)
- ALS inhibitors (group 2)
- PSII inhibitors (group 5)
- Dicamba (auxinic – group 4)



❖ Palmer amaranth (*Amaranthus palmeri*)

- | | |
|-------------------------|-----------|
| glyphosate (group 9) | 11.8-fold |
| chlorsulfuron (group 2) | 5.0-fold |
| atrazine (group 4) | 14.4-fold |
| mesotrione (group 27) | 13.4-fold |
| 2,4-D (group 4) | 3.2-fold |



Project Background

- Single application of Broadaxe or Spartan Elite can provide season-long kochia control and 96% control of Palmer amaranth up to 28 DAT (Stahlman and Reddy 2011)
- However, the longevity and activity of this premix is influenced by available soil moisture

Table 10. Residual Rates of Zidua in Sunflower

Application Timing	Use Rate by Soil Texture ¹ (ozs/A)		
	Coarse	Medium	Fine
Preplant surface	1.0 to 1.5	1.5 to 3.0	3.0 to 4.0
Preemergence	1.0 to 1.5	1.5 to 3.0	3.0 to 4.0
Early postemergence	1.0 to 1.5	1.0 to 2.0	1.0 to 2.0

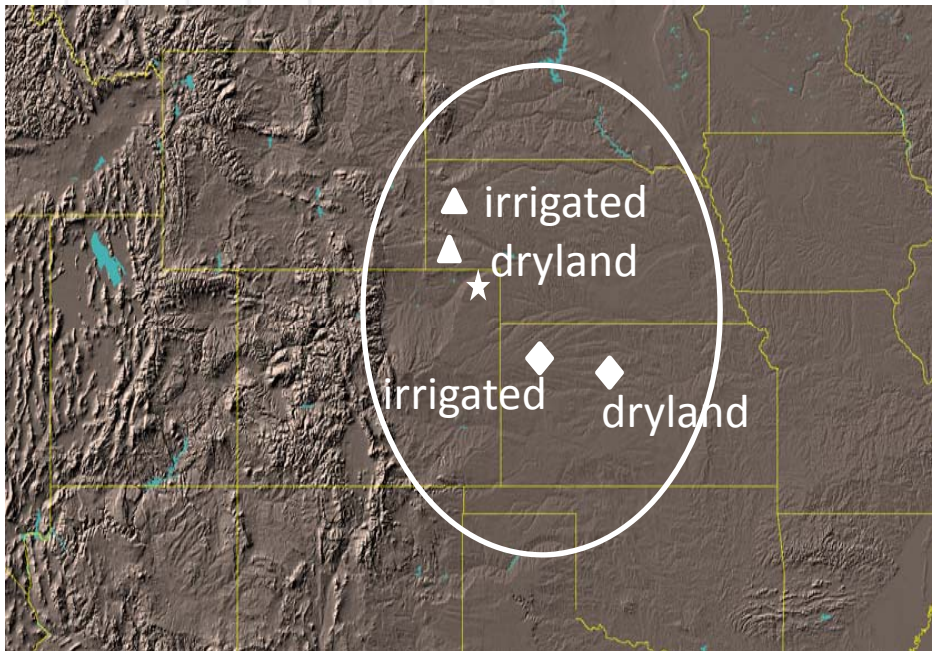
¹ Refer to **Table 3** for definition of soil-texture groups.

Objectives

- ❖ Determine the effect of rainfall on the efficacy and longevity of PRE herbicides options
- ❖ Determine the optimal timing of Zidua POST based upon the PRE herbicides applied and rainfall



Experimental Setup



- **Locations:** Hays, Colby, Scottsbluff, Sidney, Julesburg
- **Years:** 2018 and 2019
- **Planting:** mid June to early July
- **Variety:** locally adapted
- **Seeding rates:** 18,000 to 22,000 seeds/ac
- **Design:** RCBD with 4 reps

Herbicide Programs Investigated

Trt	Herbicide ^{1, 2}	Rate, oz/A	Timing
1	Prowl H ₂ O	32	PRE
2	Prowl H ₂ O <i>fb</i> Zidua	32 <i>fb</i> 1.5	PRE <i>fb</i> EPOST
3	Prowl H ₂ O <i>fb</i> Zidua	32 <i>fb</i> 1.5	PRE <i>fb</i> MPOST
4	Prowl H ₂ O <i>fb</i> Zidua	32 <i>fb</i> 1.5	PRE <i>fb</i> LPOST
5	Broadaxe	19-25	PRE
6	Broadaxe <i>fb</i> Zidua	19-25 <i>fb</i> 1.5	PRE <i>fb</i> EPOST
7	Broadaxe <i>fb</i> Zidua	19-25 <i>fb</i> 1.5	PRE <i>fb</i> MPOST
8	Broadaxe <i>fb</i> Zidua	19-25 <i>fb</i> 1.5	PRE <i>fb</i> LPOST
9	Spartan Charge	3 to 5	PRE
10	Spartan Charge <i>fb</i> Zidua	3 to 5 <i>fb</i> 1.5	PRE <i>fb</i> EPOST
11	Spartan Charge <i>fb</i> Zidua	3 to 5 <i>fb</i> 1.5	PRE <i>fb</i> MPOST
12	Spartan Charge <i>fb</i> Zidua	3 to 5 <i>fb</i> 1.5	PRE <i>fb</i> LPOST
13	Hand weeded check	-	-
14	Nontreated weedy check	-	-

¹ Abbreviations: *fb*, followed by; PRE, pre-crop emergence; EPOST, early postemergence; MPOST, mid postemergence; LPOST, late postemergence

² All treatments included glyphosate or gramoxone as PRE burndown

Data Collection and Analyses

- ❖ Crop injury, weed control (%) and weed density at biweekly interval and weed biomass at harvest
- ❖ Grain yield at harvest
- ❖ All data subjected to ANOVA
- ❖ Mean separation by Fisher's Protected LSD test at $P < 0.05$



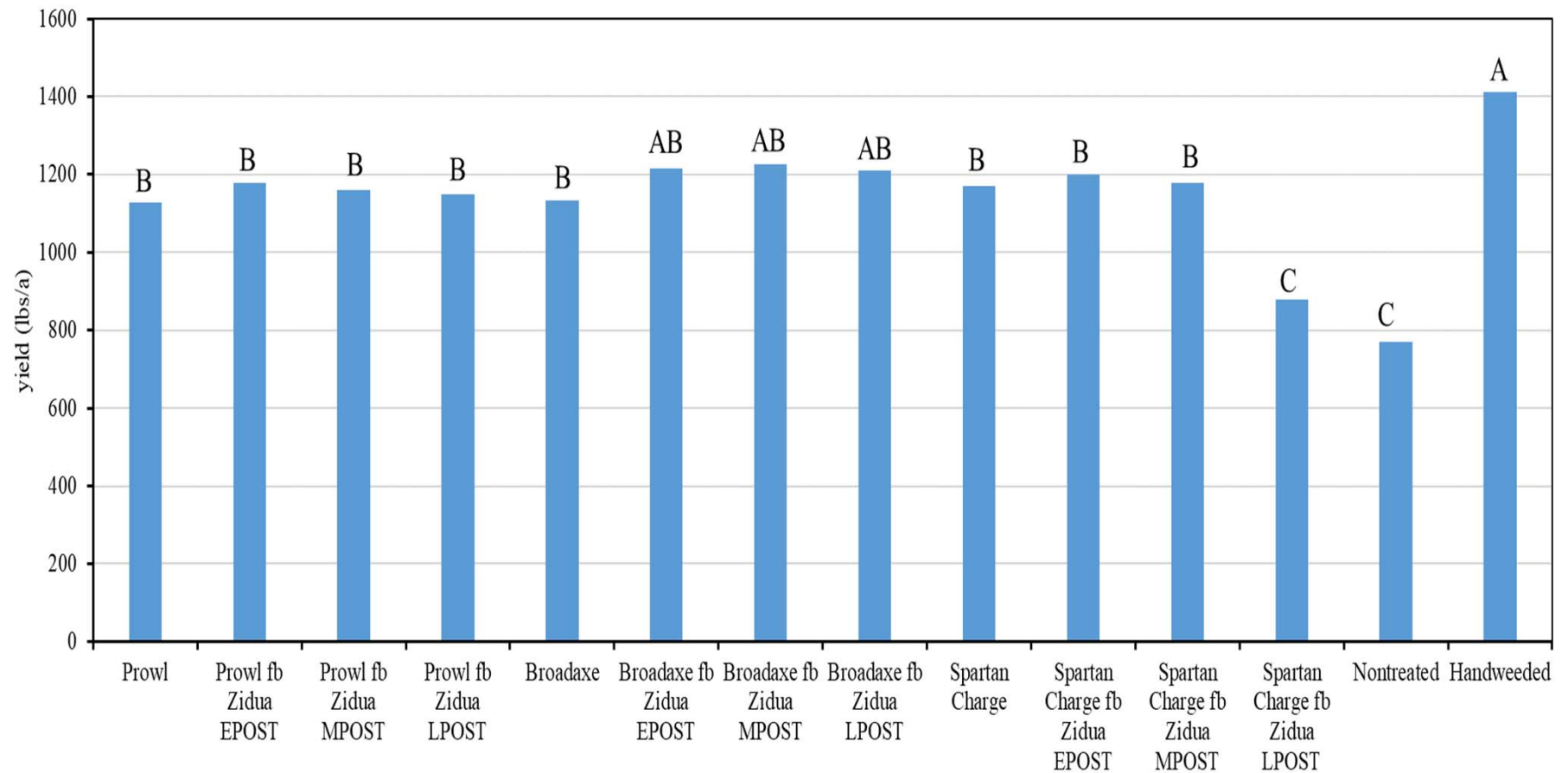
Results and Discussion

Palmer amaranth Control at Colby-2018

Herbicide (s)	Timing ^{a, b}	Rate (oz/a)	% control					Density No./sunflower row
			2 WAE	4 WAE	6 WAE	8 WAE	10 WAE	
Prowl	PRE	32	94	91	88	83	79	53
Prowl fb Zidua	PRE <i>fb</i> EPOST	32 <i>fb</i> 1.5	91	85	78	73	69	75
Prowl fb Zidua	PRE <i>fb</i> MPOST	32 <i>fb</i> 1.5	94	89	84	80	77	61
Prowl fb Zidua	PRE <i>fb</i> LPOST	32 <i>fb</i> 1.5	93	88	80	76	67	58
Broadaxe	PRE	21	97	95	92	88	83	35
Broadaxe fb Zidua	PRE <i>fb</i> EPOST	21 <i>fb</i> 1.5	98	97	92	90	88	29
Broadaxe fb Zidua	PRE <i>fb</i> MPOST	21 <i>fb</i> 1.5	97	94	92	89	82	40
Broadaxe fb Zidua	PRE <i>fb</i> LPOST	21 <i>fb</i> 1.5	99	98	94	92	89	26
Spartan Charge	PRE	5	95	94	86	83	77	50
Spartan Charge fb Zidua	PRE <i>fb</i> EPOST	5 <i>fb</i> 1.5	92	94	87	84	79	51
Spartan Charge fb Zidua	PRE <i>fb</i> MPOST	5 <i>fb</i> 1.5	92	89	85	79	70	71
Spartan Charge fb Zidua	PRE <i>fb</i> LPOST	5 <i>fb</i> 1.5	93	86	74	66	57	65
Hand weeded	–	–	100	100	100	100	100	0
Nontreated check	–	–	–	–	–	–	–	153
LSD (0.05)			7	6	11	13	15	32

^a Abbreviation: PRE, preemergence; EPOST, early postemergence; MPOST, mid postemergence; LPOST, late postemergence; *fb*, followed by; WAE, weeks after sunflower emergence

Sunflower Yield at Colby-2018

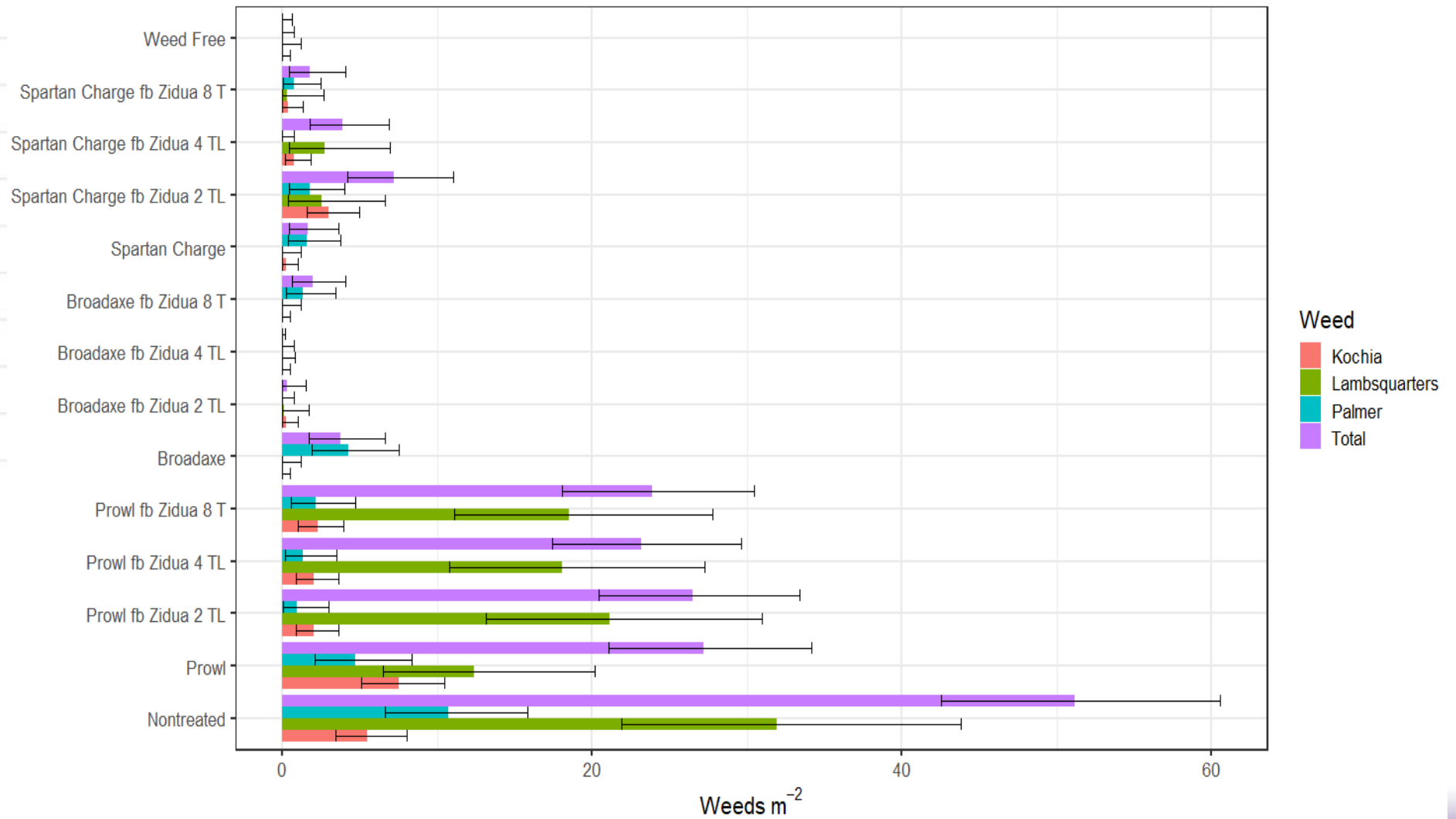


Scottsbluff-2018

Herbicide (s)	Timing (s)	Rate (oz/a)	24-July	20- Aug	11-Sep	Density	Biomass	Yield
			————— % control —————			(plants m ⁻²)	(g m ⁻²)	lbs/a -
Prowl	PRE	32	96.8 ab	95.6 a	95.6 a	1.4 b	3.8 b	913 -
Prowl <i>fb</i> Zidua	PRE <i>fb</i> EPOST	32 <i>fb</i> 1.5	95.8 ab	95.6 a	95.6 a	1.4 b	2.73 b	1010 -
Prowl <i>fb</i> Zidua	PRE <i>fb</i> MPOST	32 <i>fb</i> 1.5	96.8 ab	99 a	99 a	1.5 b	2.58 b	794 -
Prowl <i>fb</i> Zidua	PRE <i>fb</i> LPOST	32 <i>fb</i> 1.5	93.8 b	99 a	99 a	0.9 b	2.37 b	940 -
Broadaxe	PRE	19	99 ab	99 a	99 a	0 b	0 b	999 -
Broadaxe <i>fb</i> Zidua	PRE <i>fb</i> EPOST	19 <i>fb</i> 1.5	99 ab	99 a	99 a	0 b	0 b	1003 -
Broadaxe <i>fb</i> Zidua	PRE <i>fb</i> MPOST	19 <i>fb</i> 1.5	99 ab	99 a	99 a	0 b	0 b	837 -
Broadaxe <i>fb</i> Zidua	PRE <i>fb</i> LPOST	19 <i>fb</i> 1.5	99 ab	99 a	99 a	0.2 b	0.8 b	1146 -
Spartan Charge	PRE	3	99 ab	98.3 a	98.3 a	0.2 b	0.74 b	1065 -
Spartan Charge <i>fb</i> Zidua	PRE <i>fb</i> EPOST	3 <i>fb</i> 1.5	99 ab	99 a	99 a	0.3 b	1.88 b	1095 -
Spartan Charge <i>fb</i> Zidua	PRE <i>fb</i> MPOST	3 <i>fb</i> 1.5	98 ab	99 a	99 a	1.5 b	9.51 b	1404 -
Spartan Charge <i>fb</i> Zidua	PRE <i>fb</i> LPOST	3 <i>fb</i> 1.5	96.8 ab	99 a	99 a	0.7 b	0.89 b	1171 -
Handweeded Check	—	—	100 a	100 a	100 a	0 b	0 b	1114 -
Non Treated Check	—	—	0 c	0 b	0 b	17.4 a	185.12 a	901 -

^a Abbreviation: PRE, preemergence; EPOST, early postemergence; MPOST, mid postemergence; LPOST, late postemergence; *fb*, followed by; WAE, weeks after sunflower emergence

Scottsbluff-2019



Aug 14



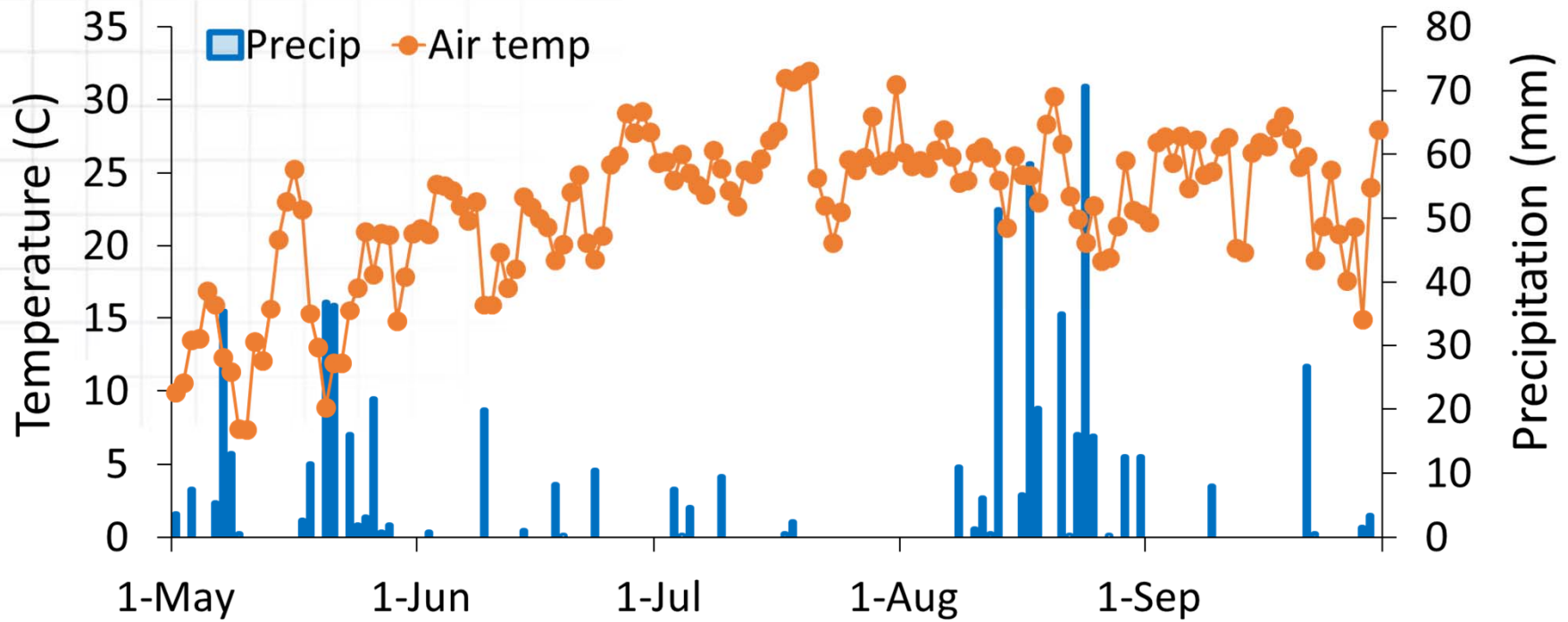
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Hays-2019

Herbicide (s)	Timing	Rate (oz/a)	July-12		Aug-16		Sep-10		Density (plants per 30 ft row)	
			Palmer amaranth	Kochia	Palmer amaranth	Kochia	Palmer amaranth	Kochia	Palmer amaranth	Kochia
Prowl H ₂ O	PRE	32	94 ab	96 a	93 ab	94 a	92 ab	94 a	4	1
Prowl H ₂ O fb Zidua	PRE <i>fb</i> EPOST	32 <i>fb</i> 1.5	98 a	94 a	98 a	92 ab	96 a	91 ab	2	1
Prowl H ₂ O fb Zidua	PRE <i>fb</i> MPOST	32 <i>fb</i> 1.5	92 ab	95 a	92 ab	94 a	92 ab	93 ab	1	1
Prowl H ₂ O fb Zidua	PRE <i>fb</i> LPOST	32 <i>fb</i> 1.5	94 ab	92 ab	94 a	91 ab	93 ab	91 ab	3	2
Broadaxe	PRE	25	98 a	98 a	99 a	99 a	99 a	99 a	0	0
Broadaxe fb Zidua	PRE <i>fb</i> EPOST	25 <i>fb</i> 1.5	96 a	99 a	98 a	99 a	99 a	98 a	0	0
Broadaxe fb Zidua	PRE <i>fb</i> MPOST	25 <i>fb</i> 1.5	97 a	98 a	99 a	98 a	99 a	99 a	0	0
Broadaxe fb Zidua	PRE <i>fb</i> LPOST	25 <i>fb</i> 1.5	96 a	99 a	99 a	98 a	99 a	98 a	0	0
Spartan Charge	PRE	5	87 b	89 b	85 b	86 b	85 b	82 b	5	2
Spartan Charge fb Zidua	PRE <i>fb</i> EPOST	5 <i>fb</i> 1.5	89 b	91 b	88 b	88 b	87 b	86 b	4	2
Spartan Charge fb Zidua	PRE <i>fb</i> MPOST	5 <i>fb</i> 1.5	86 b	88 b	85 b	85 b	84 b	83 b	6	3
Spartan Charge fb Zidua	PRE <i>fb</i> LPOST	5 <i>fb</i> 1.5	83 b	86 b	82 b	84 b	82 b	82 b	5	3
Hand weeded	–	–	100 a	100 a	100 a	100 a	100 a	100 a	0	0
Nontreated check	–	–	–	–	–	–	–	–	10	7

Hays Weather -2019



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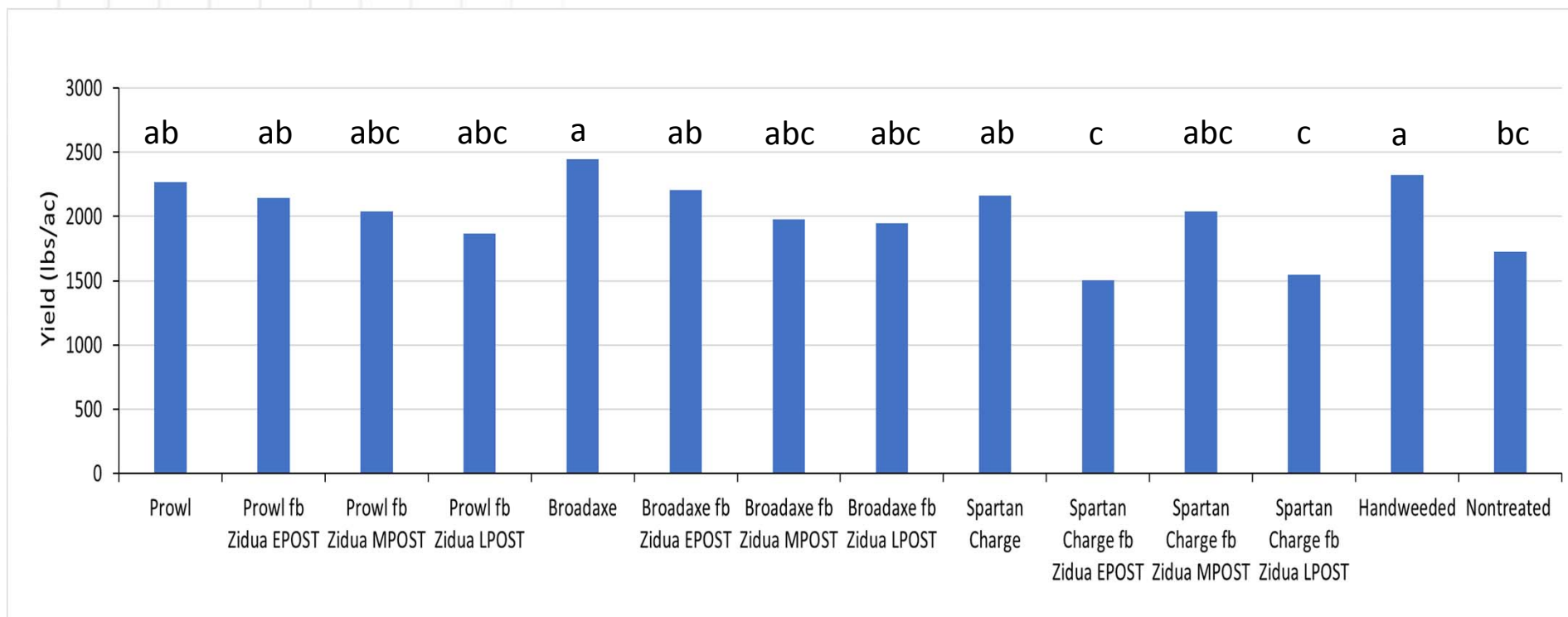


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Aug 16



Sunflower Yield at Hays-2019



Summary

- ❖ Broadaxe-based programs provided effective, season-long control of kochia and Palmer amaranth
- ❖ No additional benefit from adding Zidua POST to PRE programs
- ❖ Prowl and Spartan charge-based programs had moderate to excellent control across sites and years

Acknowledgments

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Questions?

