Economics of Herbicide Programs in Conventional, LibertyLink, and Roundup Ready 2 Xtend Soybeans Across Nebraska

2021 Crop Production Clinics



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ELEPHANT IN THE ROOM: HERBICIDE-RESISTANT WEEDS



- A 2017 survey in Nebraska found 60% of producers believe they have glyphosate-resistant weeds on their farms.
- > National adoption of PRE herbicides in soybeans has increased from 25% in 2000 to 70% in 2015.
- > Similar results in Nebraska:
 - 74% Nebraska corn acres
 - **59%** Nebraska soybean acres

Beckie et al. 2019. DOI: 10.3390/plants8060161; Sarangi and Jhala 2018. DOI: 10.1017/wet.2018.35

EXPERIMENT OBJECTIVE:

Compare 5 commercially available "pre-mixed" PRE programs followed by 4 POST programs in soybeans:



PRE Herbicide Programs						
#	Trade Name	Rate (Ac)	Cost (\$/Ac)			
I	Nontreated control					
2	Zidua Pro + Warrant	6 fl. oz + 2 qt	\$45.75			
3	Authority Elite + TriCor 4F	32 fl. oz + 20 fl. oz	\$54.25			
4	Enlite	2.8 oz	\$23.50			
5	Fierce + TriCor 4F	3 oz + 6 fl. oz	\$33.75			
6	Trivence	8.7 oz	\$29.75			
7	Zidua Pro	6 fl. oz	\$31.50			

POST PROGRAMS IN SOYBEAN IS BASED ON HR-TRAIT

2018:



Present:







Bayer.com, dekalbasgrowdeltapine.com, Stineseed.com, Enlist.com

POST Herbicide Programs						
#	Trade Name	Rate (Ac)	Cost (\$/Ac)			
I	Xtendimax + Roundup Powermax	22 fl. oz + 32 fl. oz	\$37.00			
2	Roundup Powermax	32 fl. oz	\$13.54			
3	Liberty	32 fl. oz	\$20.25			
4	Warrant + SelectMax + Cobra	2 qt + 14 fl. oz + 12.5 fl. oz	\$60.25			

Soybean Varieties & Important Dates

Study Location	HR-trait	Soybean Variety	Company	Planting Date (140k ppa)	PRE Herbicide Application Date	POST Herbicide Application Date
Clay Center	RR2X LibertyLink Conventional	S29-k3x NK P31T02L A3253	Syngenta Corteva Bayer	May 07, 2018 May 15, 2019	May 07, 2018 May 15, 2019	June 04, 2018 June 13, 2019
Concord	RR2X LibertyLink Conventional	27MX8 NK CZ2601LL P29T50	Syngenta BASF Corteva	June 05, 2018 June 06, 2019	June 06, 2018 June 08, 2019	July 20, 2018 July 11, 2019
Lincoln	RR2X LibertyLink Conventional	S29-k3x NK P31T02L A3253	Syngenta Corteva Bayer	May 13,2018 May 17,2019	May 11, 2018 May 17, 2019	June 11, 2018 June 21, 2019
North Platte	RR2X LibertyLink Conventional	28XT58 CZ2601LL A3253	Loveland BASF Bayer	May 20, 2018 May 31, 2019	May 18, 2018 June 04, 2019	June 26, 2018 July 11, 2019
Scottsbluff	RR2X LibertyLink Conventional	AG20X7 H20L3 U11-917032 A2035	Bayer Hefty Husker Genetics Bayer	May 21, 2018 June 05, 2019	May 21, 2018 June 05, 2019	July 18, 2018 July 26, 2019

RESULTS TO DISCUSS TODAY

- I. Weed Control and Biomass Reduction
- 2. Crop Injury
- 3. Crop Yield and Economics

PRE HERBICIDE PROGRAM WEED CONTROL & BIOMASS REDUCTION

> At 28 d after PRE, all PRE programs provided \geq 80% control of:

- Palmer amaranth
- Common lambsquarters
- Velvetleaf
- Large crabgrass, foxtails and sandbur
- Kochia (65-95%)

> PRE programs provided 74-94% weed biomass reduction at 28-45 d after PRE.



Nontreated Control





Authority Elite (32 fl. oz) + Tricor (20 fl. oz)



Enlite (2.8 oz)



Fierce MTZ (3 oz plus 6 fl. oz co-pack)



Trivence (8.7 oz)



Zidua Pro (6 fl. oz)

POST HERBICIDE PROGRAM WEED CONTROL & BIOMASS REDUCTION

- > At 28 d after POST, all POST programs provided \geq 85-95% control of:
 - Palmer amaranth
 - Common lambsquarters
 - Velvetleaf
 - Large crabgrass, foxtails and sandbur
 - Kochia (29-91%)
- > POST programs provided 86-99% weed biomass reduction 28 days after PRE.











PRE FB POST HERBICIDE PROGRAM CROP SAFETY

PRE Herbicide Injury:

 \geq **4%** crop injury at **28** days after PRE

POST Herbicide Injury:

- RR2X varieties had no crop injury
- LibertyLink varieties had 12% dicamba injury (0 to 30%)
- Conventional varieties had 9% PPO-burn and 12% dicamba injury





LibertyLink varieties yielded comparable to RR2X cultivars



Some PRE fb POST programs in conventional varieties were comparable to RR2X cultivars

ECONOMIC ANALYSIS

USDA: \$8.50 per bushel for GMO-soybeans, \$9.54 per bushel for Non-GMO soybeans

Gross Profit Margin:

- Gross Revenue per Acre Weed Management Program Costs
 - Herbicides, adjuvants, custom application, and HR-Trait costs
- > "After paying for the weed management program, how much gross revenue remains?

Benefit-Cost Ratio:

- > (Gross Revenue per Acre Gross Revenue per Acre for nontreated control) + Weed Management Program Cost
- > "Per dollar invested into a weed management program how much benefit was obtained?"





Gross Profit Margin for Conventional/HR-Soybean are Comparable For Some Programs

PRE Herbicide Program



Benefit/Cost Ratio for Conventional PRE fb POST is Lower

CONCLUSIONS

WEED CONTROL:

- > All PRE fb POST programs worked well to control weed species (excluding Kochia)
 - ≥80% control 28 days after PRE
 - ≥ 85-95% control 28 days after POST

CROPYIELD:

- LibertyLink varieties were similar to RR2X in most programs
- > Two conventional programs were similar to RR2X

ECONOMICS:

- > In areas supported by price premiums, conventional soybeans can offer similar gross profit margins to HR-soybean
 - If weed spectrum is right. Limited POST options!
- LibertyLink soybeans were comparable to RR2X for many programs

Control of Roundup Ready/LibertyLink Volunteer Corn in Enlist[™] Corn

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VOLUNTEER CORN IS A PROBLEMATIC WEED SPECIES

Well Documented In Many Crops: 1970s - Present

- Reduction in crop yield or crop quality
- Management of volunteer corn



6% to **87**%



4 to 8%



United Soybean Board, Hosted on Flickr; User: Captrosha, Hosted on Flickr; Hosted by SouthernStates

MANAGEMENT OF VOLUNTEER CORN IN CORN HAS REQUIRED HR-TRAIT ROTATION

Planted Crop HR Trait	Volunteer Conventional	Volunteer Roundup Ready	Volunteer LibertyLink	Volunteer RR/LL
Conventional	Ø	Ø		
Roundup Ready				
LibertyLink				
RR/LL				

ENLIST™-A NEW MANAGEMENT OPTION

Enlist[™] hybrids:

- New multiple herbicide-resistant trait developed by Corteva Agriscience
 - > 2,4-D choline
 - glyphosate
 - aryloxyphenoxypropionate (FOPs)
 - glufosinate (separate trait)





Enlist.com; Corteva.com

ENLIST[™] DOES NOT PROVIDE RESISTANCE TO ALL ACCASE HERBICIDES

ACCASE INHIBITORS (Group 1)					
Chemical Family	Common Name	Trade Name	Manufacturer		
	clodinafop	Discover® NG	Syngenta		
	cyhalofop	Clincher®	Corteva		
Aryloxyphenoxypropionate	fenoxaprop	Ricestar®	Bayer		
(10F3)	fluazifop	Fusilade® DX	Syngenta		
	quizalofop	Assure® II	Corteva/AMVAC		
Cyclohexanediones	clethodim	Select Max®	Sygenta		
(DIMs)	sethoxydim	Poast Plus®	BASF		
Phenylpyrazolin (DENs)	pinoxaden	Axial® XL	Syngenta		

RESEARCH OBJECTIVES & HYPOTHESES

Objectives:

- > Evaluate 6 Group 1 herbicides applied at two application times for:
 - Control of Roundup Ready/LibertyLink volunteer corn
 - Crop injury and yield loss (and yield loss from volunteer corn)

2018-2019 EXPERIMENTAL LOCATION

South Central Agricultural Laboratory (Clay Center, NE)

- Pivot Irrigated with four replications
- Cross-planted Volunteer Corn:
 - o 15,000 plants per acre
 - o April 26, 2018 & April 23, 2019









HYBRIDS & PRE/POST HERBICIDE PROGRAM

Enlist Hybrids: 36,000 plants per acre

- 05/07/2018- Mycogen MY10V09
- 05/01/2019- Mycogen MY11V17

PRE:

Acuron at 2.5 qt/Ac

Blanket POST: 1 week after treatments

- 2018- Roundup PowerMAX at 32 fl oz/Ac
- 2019- Liberty at 44 fl oz/Ac

HERBICIDE TREATMENT APPLICATIONS

 \succ CO₂-pressurized backpack sprayer: 15 GPA at 40 psi.

Early POST (E-POST) – 12" height

- June 12, 2018, June 13, 2019
- Late POST (L-POST) 20" height
 - June 18, 2018, June 24, 2019

HERBICIDE TREATMENTS

Trootmont	Rate (f	Enlist	
ireatment	E-POST (12")	L-POST (20")	• E-P
Nontreated Control			• L-P
Weed-free Control			
Fusilade DX	4	6	Г
Assure II	4	5	FOPS
Fusion	6	10	
Select Max	8	14	
Poast Plus	12	16	
Axial XL	12	16.4	}-DEN
	·	·γ	
	v 5	V7-V8	

Enlist Corn Heights:

- E-POST: (V7, 22")
- L-POST: (V8, 57-59")

RESULTS TO DISCUSS TODAY

- 1. Control of volunteer corn
- 2. Crop injury
- 3. Yield

FOPS PROVIDED 99% CONTROL OF VOLUNTEER CORN REGARDLESS OF APPLICATION TIME



Fluazifop (Fusilade DX)



E-POST

Quizalofop (Assure II)



Fluazifop/fenoxaprop (Fusion)



DIMS & DENS CAUSE UNACCEPTABLE CROP INJURY



2019 GROWING SEASON CHALLENGES

Mother Nature:

- Cool, wet spring (wind damage)
- > 3+ strong windstorms early/mid season (green snap \approx 34k to 22k ppa)
- ➢ 50% defoliating hail at R3...

Our Workaround:

Separate 2018 and 2019 for analysis of yield!

2018-2019 Crop Yield:



2018-2019 Crop Yield: No yield loss for FOP herbicides



2018-2019 Crop Yield: DIM & DEN herbicides result in unacceptable yield loss



YIELD LOSS FROM VOLUNTEER CORN?

- > 15,000 plants per acre did not directly reduce crop yield.
 - Distribution, (clumped vs. individual plants)
 - Contributed to yield?!



FINAL THOUGHTS

> Quizalofop (Assure II) is the only currently labeled ACCase product for use in Enlist.

Future Direction:

- > Yield effects of other spatial distributions of volunteer corn (clumped)
- Pollen-mediated gene flow of Enlist HR-trait into non-tolerant hybrids.

SUGGESTED ROTATION

- Year 1: Roundup Ready Corn
- Year 2: Roundup Ready/LibertyLink Corn

Year 3: Enlist Corn

Year 4: Soybeans (with Select or Poast)

Planted Crop HR Trait	Volunteer Conventional	Volunteer Roundup Ready	Volunteer LibertyLink	Volunteer RR/LL	Volunteer Enlist
Conventional	\bigotimes	\bigotimes	\bigotimes	\bigotimes	\bigotimes
Roundup Ready		\bigotimes		\bigotimes	\otimes
LibertyLink			\mathbf{O}	\mathbf{O}	\odot
RR/LL				\bigotimes	\otimes
Enlist					Ø

NEED TO ROTATE TO SOYBEANS AFTER ENLIST CORN TO CONTROL VOLUNTEER CORN

