2023 Conventional Variable-Rate Tank Mix Impact on Waterhemp Control and Soybean Yield

Andrew Lueck[1] and Jenna Whitmore[2]

Next Gen Ag LLC, Renville, MN; [1]Research Lead and [2]Research Manager

Objectives were to achieve 95% control waterhemp in soybean, demonstrate low injury and no yield impact, and provide an unbiased evaluation of entries to give growers a greater level of comfort using variable-rate tank mixes. Growers should use the data to determine if a conventional variable-rate tank mix waterhemp program can provide the acceptable control at an economical cost based on local supplier pricing and availability of products.

MATERIALS AND METHODS

Experiments were conducted on a moderate natural population of ALS and glyphosate-resistant waterhemp near Renville, Minnesota, in 2023. Soil was a fine-textured webster-clay loam soil with 5.0% organic matter and a 6.6 soil pH. Spring tillage was a field cultivator at 3" depth. Becks 1630E soybean was seeded 1.25 inches deep on 30-inch row spacings at 130,000 seeds per acre in the waterhemp control and yield studies on May 22 and May 26; emerging May 29 and June 3, respectively. Waterhemp control study preemergence herbicide treatments were applied to soybean on May 23 and early-postemergence treatments to V3 soybean on June 14 (Table 1). Soybean yield study preemergence herbicide treatments were applied to soybean on May 27 and early-postemergence treatments to V2 soybean on June 21. All treatments applied with bicycle sprayer in 15 GPA spray solution through AIXR11002 air-induction flat fan nozzles pressurized with CO_2 at 25 psi to the center two rows of four row plots 40 feet in length. The soybean yield study was maintained weed free with a blanket application of Liberty 280SL at 32 fl oz late-postemergence with product being applied to plots 50 feet in length.

Waterhemp control was evaluated June 5, June 28, July 10, and July 27. Herbicide injury was observed in the waterhemp control study seven days after emergence and evaluations were recorded June 5, with no visible injury remaining 14 days after emergence. Waterhemp and injury evaluations were a visual estimate of percent fresh weight reduction in center two treated rows compared to adjacent untreated strips. Experimental design was randomized complete block with 4 replications. Data were analyzed with GLM procedure of SAS (Statistical Analysis Software 2023, version 9.4M8, SAS Institute, Inc.) at alpha=0.10 and differences are determined with 90% confidence; meaning, if the study were repeated 100 times, that 90 times out of 100 we would expect treatments that are statistically similar (within one LSD value of each other) to continue to be similar.

Soybean yield study was evaluated for visual injury 7 and 14 days after emergence with no injury being observed. Yield data were collected on October 3 utilizing a Hege 160 two-row small plot research combine equipped with a HarvestMaster large plot weigh hopper. The middle two rows of the four-row 50-foot plot were harvested and samples were taken with moisture and test weights recorded using a Perten 5200-A moisture tester. Experimental design was randomized complete block with 6 replications. Data were analyzed with GLM procedure of SAS (Statistical Analysis Software 2023, version 9.4M8, SAS Institute, Inc.) at alpha=0.10 and differences are determined with 90% confidence.

Table 1. Application information for Renville giant ragweed control trials in 2023.

Description	Waterhemp Control		Soybean Yield	
Application Code	A	B	A	B
Date	May 23	June 14	May 27	June 21
Time of Day	10:00 AM	9:00 AM	10:00 AM	10:00 AM
Air Temperature (F)	79	69	80	86
Relative Humidity (%)	45	65	44	50
Wind Velocity (mph)	7	3	4	3
Wind Direction	S	NW	SW	SW
Soil Temp. (F at 6")	60	68	72	72
Soil Moisture	Good	Fair	Good	Dry
Cloud Cover (%)	10	100	5	5
Crop Growth Stage (avg)	-	V3	-	V2
Waterhemp Height	-	4"	-	-

RESULTS AND DISCUSSION

Waterhemp were late to emerge likely due to low soil temperatures and lack of early rainfall at the A+14 evaluation (Table 2). At the B+14 evaluation waterhemp control ranged from 80 to 98% and averaged 92.6%. This evaluation had the lowest ratings likely due to the waterhemp population emerging in now warmer soils, but not being impacted by the preemergence soil residual herbicides which had lack of rainfall for activation. Only 2 inches of rain occurred from preemergence application to last evaluation. Waterhemp control ranged from 80 to 98% averaging 92.0% and ranged from 88-98% averaging 93.8% at B+28 and B+42, respectively. At crop canopy, B+42, only 8 of the 20 treatments achieved the target objective of 95% waterhemp control. In general, the heavy residual programs strengths would have been best with at least one single rainfall event exceeding 1 inch for best activation.

Injury was observed 7 days after crop emergence from the preemergence applications and ranged from 0-9% averaging 2.3% (Table 2). No crop injury was visible at 14 days after crop emergence. The crop injury was not consistent with any single active or combination of actives; thus, no clear conclusions could be drawn.

Yield data was collected from a second, independent six replication study where the impact of weed competition was mitigated to allow clear conclusions to be drawn solely on the basis of crop safety. Yield ranged from 40-48 bushels of soybean per acre and averaged 44.4 bushels of soybean per acre (Table 2). In general, the combinations including "Blanket" or sulfentrazone tended to yield lower than combinations without. Sulfentrazone containing treatments averaged 42.8 bushels of soybean per acre, while non-sulfentrazone containing treatments averaged 46.0 bushels of soybean per acre. However, sulfentrazone containing treatments also tended to have increased weed control compared to non-sulfentrazone containing treatments. This is likely due to sulfentrazones higher solubility characteristics compared to Valor SX(flumioxazin), Warrant (encapsulated acetachlor), or Zidua SC (pyroxasulfone) which means it activates in the soil with less rainfall similar to S-metolachlor(Dual Magnum), dimethenamid-p(Outlook), or saflufenacil(Sharpen).

Table 2. Waterhemp control and soybean yield in 2023.

		App.	Waterhemp Control				Injury	Yield
Treatment[a]	**Rate**	**Code[b]**	**A+14[c]**	**B+14**	**B+28**	**B+42**	**A+14**	**Harvest**
	oz/A* or fl oz/A		----------%----------				%	Bu/A[d]
Valor+War.+Zidua SC+Flex[e]	1.5*+30+3.25+7.5	A	100	94	93	94	1	48
Valor+War.+Zidua SC / Flex+HSMOC	1.5*+30+3.25 / 7.5	A / B	99	88	91	90	9	48
Valor+War. / Zidua SC+Flex+HSMOC	1.5*+30 / 3.25+7.5	A / B	98	91	90	91	8	46
Valor+Zidua SC / War.+Flex+HSMOC	1.5*+3.25 / 30+7.5	A / B	98	93	88	93	0	44
Valor / War.+Zidua SC+Flex+HSMOC	1.5* / 30+3.25+7.5	A / B	93	93	89	93	1	48
Valor+War.+Zidua SC+Flex	2*+40+4+10	A	98	95	91	91	0	46
Valor+War.+Zidua SC / Flex+HSMOC	2*+40+4 / 10	A / B	94	85	86	88	0	45
Valor+War. / Zidua SC+Flex+HSMOC	2*+40 / 4+10	A / B	100	96	95	95	5	46
Valor+Zidua SC / War.+Flex+HSMOC	2*+4 / 40+10	A / B	100	98	97	98	5	46
Valor / War.+Zidua SC+Flex+HSMOC	2* / 40+4+10	A / B	93	95	93	94	1	43
Valor+War.+Blanket+Flex	1.5*+30+6*+7.5	A	96	94	94	93	1	40
Valor+War.+Blanket / Flex+HSMOC	1.5*+30+6* / 7.5	A / B	88	94	93	93	1	42
Valor+Blanket / War.+Flex+HSMOC	1.5*+6* / 30+7.5	A / B	100	86	89	91	1	44
Valor+War.+Blanket+Flex	2*+40+8*+10	A	100	95	95	96	1	42
Valor+War.+Blanket / Flex+HSMOC	2*+40+8* / 10	A / B	90	80	80	92	0	45
Valor+Blanket / War.+Flex+HSMOC	2*+8* / 40+10	A / B	100	96	95	97	1	43
Valor+War.+Blanket+Flex	2*+48+10*+12	A	100	95	93	95	4	43
Valor+War.+Blanket / Flex+HSMOC	2*+48+10* / 12	A / B	99	95	95	97	0	43
Valor+Blanket / War.+Flex+HSMOC	2*+10* / 48+12	A / B	100	91	95	96	3	43
Valor+War.+Blanket+Flex+Zidua SC	2*+40+8*+10+3.25	A	100	97	98	99	3	43
LSD (0.1)			**6**	**11**	**11**	**6**	**4**	**5**

[a]PRE treatment applications contained no additional adjuvants.
[b]Application codes refer to the information in Table 1.
[c]A+[#] or B+[#]=Days after "A" or "B" application.
[d]Bu/A=Soybean yield in bushels per acre corrected to a standard moisture of 13.5%.
[e]AMS=Valor=Valor SX; Flex=Flexstar; War=Warrant; HSMOC=Destiny HC 0.5%v/v.

Ratios of a base treatment that included Blanket, Valor SX, Warrant, and Flexstar preemergence were evaluated to observe if there was an ideal level strongly based PPO program impact on waterhemp control or soybean yield (Table 3). In a year with inconsistent waterhemp pressure, lack of rainfall for residual activation, and drought stress on secondary flushes of waterhemp germination, there was much to be desired in both the waterhemp control and soybean yield data from the ratio treatments. One would have hypothesized that weed control would increase as rate ratio increased and that soybean yield would have remained the same or decreased as rate ratio increased. Waterhemp control was not consistent with rate ratios. Soybean yield was non-significant, but trended the opposite direction hypothesized. This data set is inconclusive.

Table 3. Ratio rate increase on waterhemp control and soybean yield in 2023.

		App.	Waterhemp Control				Injury	Yield
Treatment[a]	**Rate**	**Code[b]**	**A+14[c]**	**B+14**	**B+28**	**B+42**	**A+14**	**Harvest**
	oz/A* or fl oz/A		----------%----------				%	Bu/A[d]
Blanket+Valor SX+War.+Flexstar	5+1.25*+24+6.5	A	99	95	96	97	0	43
Blanket+Valor SX+War.+Flexstar	6+1.5*+30+7.5	A	99	92	95	93	3	43
Blanket+Valor SX+War.+Flexstar	7+1.75*+36+8.5	A	99	86	83	90	0	45
Blanket+Valor SX+War.+Flexstar	8+2*+40+10	A	94	76	84	83	4	47
Blanket+Valor SX+War.+Flexstar	9+2*+44+11	A	100	91	93	94	4	45
Blanket+Valor SX+War.+Flexstar	10+2*+48+12	A	100	94	93	93	6	46
Blanket+Valor SX+War.+Flexstar	11+2*+56+14	A	96	78	76	85	5	47
Blanket+Valor SX+War.+Flexstar	12+2*+64+16	A	99	90	91	93	6	47
LSD (0.1)			**6**	**11**	**11**	**6**	**4**	**NS**

[a]PRE treatment applications contained no additional adjuvants.
[b]Application codes refer to the information in Table 1.
[c]A+[#] or B+[#]=Days after "A" or "B" application.
[d]Bu/A=Soybean yield in bushels per acre corrected to a standard moisture of 13.5%.
[e]War=Warrant.

Combined analysis of the non-ratio related treatments was acquired across three growing seasons from 2021-2023. The conventional variable-rate tank mixes combined data support many of the past conclusions drawn by the project (Table 4). Growers could consider applying the residual CVRTM approach PRE as a potential cost and time saving one-time application in years with average early rainfall. However, in years with below average early rainfall the grower must be prepared to utilize a two-pass approach that includes a contact or systemic product. Data suggests the reduced rates of PRE products when combined with more modes of action can achieve 95%+ waterhemp control in moderate to severe infestation environments. Adding a low rate of Flexstar PRE when there is a low chance of 0.5-1.0 inches of rainfall in the 7-day forecast is encouraged. This conventional program is universal across all soybean genetics minimizing tank cleanout events for operations that grow multiple herbicide tolerant soybean genetics.

Table 4. Waterhemp control 3-year combined analysis from 2021-2023.						
		App.	Waterhemp Control			
Treatment[a]	Rate	Code[b]	A+14[c]	B+14	B+28	B+42
	oz/A* or fl oz/A		----------%----------			
Valor+War.+Zidua SC+Flex[d]	1.5*+30+3.25+7.5	A	100	84	86	89
Valor+War.+Zidua SC / Flex+HSMOC	1.5*+30+3.25 / 7.5	A / B	95	87	91	90
Valor+War. / Zidua SC+Flex+HSMOC	1.5*+30 / 3.25+7.5	A / B	97	87	92	91
Valor+Zidua SC / War.+Flex+HSMOC	1.5*+3.25 / 30+7.5	A / B	95	82	91	90
Valor / War.+Zidua SC+Flex+HSMOC	1.5* / 30+3.25+7.5	A / B	94	71	90	84
Valor+War.+Zidua SC+Flex	2*+40+4+10	A	99	94	94	94
Valor+War.+Zidua SC / Flex+HSMOC	2*+40+4 / 10	A / B	97	84	95	95
Valor+War. / Zidua SC+Flex+HSMOC	2*+40 / 4+10	A / B	97	81	94	92
Valor+Zidua SC / War.+Flex+HSMOC	2*+4 / 40+10	A / B	97	83	94	95
Valor / War.+Zidua SC+Flex+HSMOC	2* / 40+4+10	A / B	95	76	90	91
Valor+War.+Blanket+Flex	1.5*+30+6*+7.5	A	99	89	93	90
Valor+War.+Blanket / Flex+HSMOC	1.5*+30+6* / 7.5	A / B	95	81	94	93
Valor+Blanket / War.+Flex+HSMOC	1.5*+6* / 30+7.5	A / B	96	74	89	90
Valor+War.+Blanket+Flex	2*+40+8*+10	A	100	89	93	93
Valor+War.+Blanket / Flex+HSMOC	2*+40+8* / 10	A / B	97	87	93	95
Valor+Blanket / War.+Flex+HSMOC	2*+8* / 40+10	A / B	99	89	95	95
Valor+War.+Blanket+Flex	2*+48+10*+12	A	100	85	92	94
Valor+War.+Blanket / Flex+HSMOC	2*+48+10* / 12	A / B	100	95	98	98
Valor+Blanket / War.+Flex+HSMOC	2*+10* / 48+12	A / B	100	90	96	95
Valor+War.+Blanket+Flex+Zidua SC	2*+40+8*+10+3.25	A	100	90	99	98
LSD (0.1)			**6**	**15**	**8**	**8**

[a]PRE treatment applications contained no additional adjuvants.
[b]Application codes refer to the information in Table 1.
[c]A+[#] or B+[#]=Days after "A" or "B" application.
[d]AMS=Valor=Valor SX; Flex=Flexstar; War=Warrant; HSMOC=Destiny HC 0.5%v/v.

CONCLUSION

In 2023, sulfentrazone containing treatments averaged 42.8 bushels of soybean per acre, while non-sulfentrazone containing treatments averaged 46.0 bushels of soybean per acre. However, sulfentrazone containing treatments also tended to have increased weed control compared to non-sulfentrazone containing treatments. This is likely due to sulfentrazones higher solubility characteristics compared to Valor SX(flumioxazin), Warrant (encapsulated acetachlor), or Zidua SC (pyroxasulfone) which means it activates in the soil with less rainfall. Only 2 inches of rain occurred from preemergence application to last evaluation (75 days). In a year with more significant early rainfall, one may have observed increased impact of Valor SX+Warrant preemergence combo injury, however, in 2023 that combination did not appear to have an impact on soybean yield.

Growers could consider applying the residual CVRTM approach PRE as a potential cost and time saving one-time application in years with average early rainfall. However, in years with below average early rainfall the grower must be prepared to utilize a two-pass approach that includes a contact or systemic product. This conventional program is universal across all soybean genetics minimizing tank cleanout events for operations that grow multiple herbicide tolerant soybean genetics. Next Gen Ag LLC is responsible for conducting and summarizing information, but is not liable for any decisions made on the basis of this study or publication.

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