

Managing Waterhemp in Soybean with Layered Residual Herbicides - A Strategy for Controlling ALS and Glyphosate Resistant Waterhemp in Minnesota, 2015 and 2016.

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Tall waterhemp (*Amaranthus tuberculatus*) is expanding its reach across Minnesota and herbicide resistant populations are becoming more commonplace. Most waterhemp populations in Minnesota are resistant to ALS (Group-2) herbicides. In 2007, waterhemp populations resistant to glyphosate (Group-9) were reported and in 2015 and 2016, populations in southern Minnesota were confirmed resistant to PPO herbicides (Group-14), with some populations resistant to all three herbicide groups, Group-2, Group-9 and Group-14¹. New management strategies to control waterhemp are needed. Waterhemp seedlings emerge over an extended period, frequently outlasting the residual control achieved by herbicides applied before or at crop planting. One strategy for dealing with glyphosate-, PPO- and ALS- resistant waterhemp is to layer Group-15 soil residual herbicides, preemergence (PRE) followed by additional Group-15 residual herbicide at early postemergence (POST), about 30 days after planting, Figure 1. Several residual herbicides may be applied postemergence to the crop alone or in combination with other post-emergent herbicides. When activated by rainfall, these post-applied residual herbicides can extend the duration of waterhemp seedling control. The objective of this trial was to evaluate and demonstrate the effectiveness of layering soil residual herbicides for control of common waterhemp in soybeans in southeastern Minnesota.

Materials and Methods:

Three Group-15 herbicides were evaluated in this study, 1) Dual II Magnum (s-metolachlor) at 1.5 pts/A PRE only or 1.5 pt/A PRE followed by 1.0 pt/A POST, 2) Outlook (dimethenamid-P) at 18 fl oz/A PRE only or 14 fl oz/A PRE followed by 10 fl oz/A POST, and 3) Warrant (acetochlor) at 1.6 qt/A PRE only or 1.6 qt/A PRE followed by 1.6 qt/A POST. Additional treatments were included in 2016 to evaluate the 1) optimum time for POST layered application to be made, (20, 29 or 44 days after PRE or DAP), 2) effect of layering two different Group-15 herbicides, used at maximum labelled rates, and 3) effectiveness of layering multiple residual SOAs, Group-14 Valor SX (flumioxazin) followed by a Group-15 Dual II Magnum.

Herbicide selection was based on their known effectiveness for controlling common waterhemp and their flexibility of application timing. Rates used were based on soil type and seasonal limits. The waterhemp population at Rochester is ALS-resistant. Pursuit (imazethapyr) in 2015 and FirstRate (chloransulam) in 2016 were used preemergence to assist in controlling other broadleaf weeds present in this study. The research site was a Lawler loam series that was fall chisel plowed, spring disked and field cultivated prior to planting. Stine 22LD23 (LibertyLink) soybean was planted May 5, 2015 in 30-inch rows at 135,000 seeds per acre. Stine 23LF32 (LibertyLink) was planted on May 4, 2016 in 30-inch rows at 165,000 seeds per acre. A randomized complete block was used with three replications. Preemergence treatments were applied immediately after planting. Layered soil residuals herbicides were applied POST 34 days (2015) and 22, 29 or 44 days (2016) after PRE herbicides were applied. Evaluations were taken from May through September. The center two rows of each plot were machine harvested on October 13, 2015 and 2016. Application dates, environmental conditions, and weed stages can be found in Table 1. Performance ratings for common waterhemp, common lambsquarters and grass control and crop response are in Tables 2 - 8.

Discussion

1. In 2015, layered or sequential applications of Dual II Magnum, Outlook or Warrant herbicides provided significantly better (95, 94 and 90%, respectively) season-long control of waterhemp compared to their PRE only treatments (81, 71, and 62%, respectively), 9/29/15 rating, Table 2. The results were similar in 2016, with the layered herbicides providing significantly better (94, 95 and 91%, respectively) season long control compared to their PRE only treatments (76, 79, and 79%, respectively), 9/26/16 rating, Table 3. The two-year average waterhemp control achieved with layering herbicides in this study was 20% greater than PRE only, Figure 2. An open soybean canopy well into July allowed waterhemp to continue to emerge and compete with the crop, Figure 3.

- Layering two different Group-15 herbicides, Zidua (pyroxasulfone) at 2.5 oz/A PRE followed by Outlook at 18 fl oz/A POST, (maximum labelled rates), provided satisfactory control, 93%, 9/26/ 26 rating.
- These data show the optimum time for applying the POST layered residual Group-15 herbicide was about 30 DAP, Table 4. The 20 DAP and 29 DAP provided 92 to 98% season-long control with minimal waterhemp escapes, which was significantly better than the later application at 44 DAP, which resulted in escapes by the June 27 rating, 85% control. This correlates with their average half-life² (~30 days) as control starts to diminish about 30 days after PRE application, Table 4. This shows that when the second residual application is delayed, it would be necessary to include a postemergence herbicide that effectively controls emerged waterhemp and other weeds, as Group-15 herbicides do not control emerged waterhemp.
- Layering effective residual, SOA's is a good strategy for controlling waterhemp populations. Group-14 Valor SX applied PRE followed by Group-15 Dual II Magnum applied POST provided very good season long waterhemp control, Table 5. When compared to the layered Group-15 herbicide programs, the Valor SX followed by Dual II Magnum provided excellent control (98%), which was similar to the layered Dual II Magnum (94%) and Outlook (95%) and significantly better than the Warrant (91%) control, Table 5. However, because populations of PPO-resistant waterhemp have been increasing in Minnesota, the effectiveness of a PRE Group-14 herbicide may be diminished and/or provide a shorter duration of control. Layering an effective residual Group-15 herbicide would make this a more durable system.

This trial demonstrates that layering of effective residual herbicides is a strategy that could provide season long control of waterhemp. However, as waterhemp populations become resistant to multiple herbicides, the need for new weed management strategies, including non-chemical options, must be implemented. (University of Minnesota Extension Regional Office, Rochester).

- Heap, I. The International Survey of Herbicide Resistant Weeds. Online. November, 2016 . Available www.weedscience.org
- National Pesticide Information Center, <http://npic.orst.edu/HPT/index.html>.

Table 1. Application timing, plant stages, environmental conditions in 2016.

Date	5/4	5/24	6/2	6/17
Treatment	PRE	POST I	POST II	POST III
Temperature (F)				
Air	59.0	76.0	68.0	72.0
Soil	56.3	71.3	69.5	68.5
Relative Humidity (%)	40	64	56	78
Wind (mph)	12	5	9	10
Soil Moisture	Normal	Normal	Normal	Normal
Soybean				
Stage		VC	V2	V5
Height (inch)		2.0	4.4	11.2
Common Waterhemp				
Density (ft ²)				40.5
Height (inch)			1.2	4.9
Rainfall after each application				
Week 1	0.87	2.79	0.9	0.41
Week 2	0.58	1.22	3.75	0.65
Week 3	0.21	2.66	0.3	1.66

Figure 1. Concept of layering soil residual herbicide (PRE / POST) to control waterhemp populations in soybean.

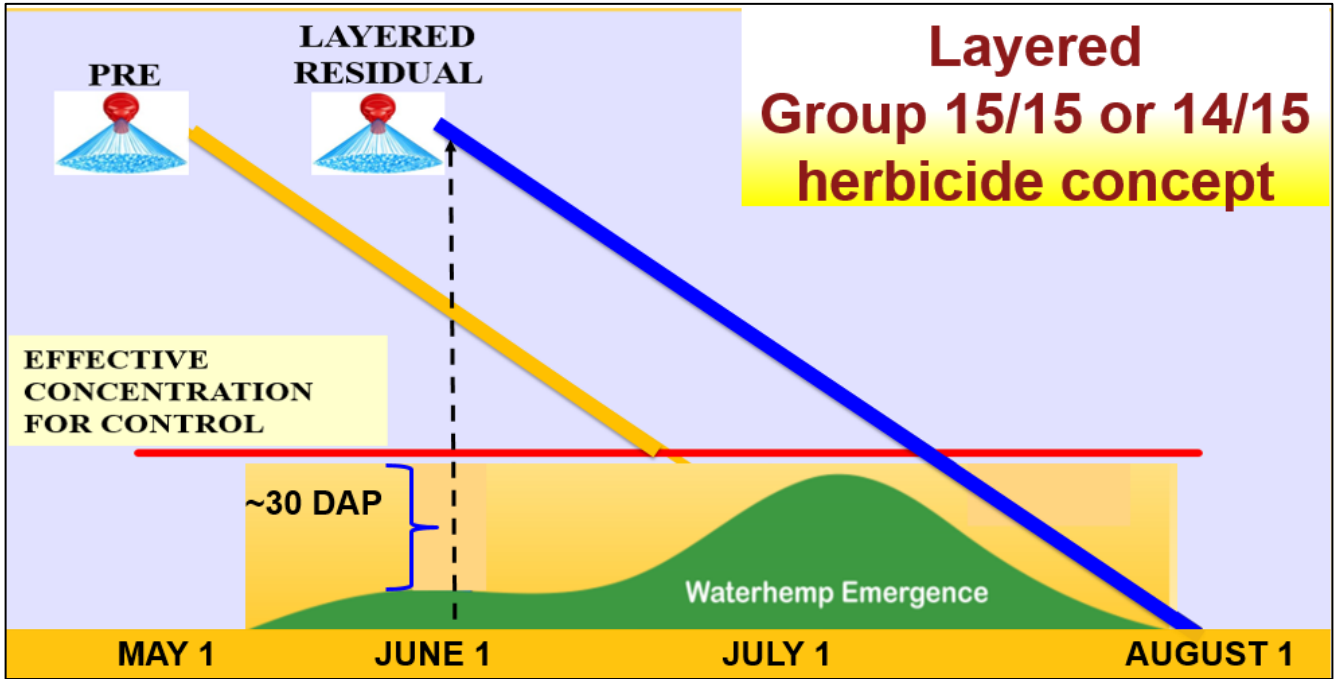


Figure 2. Average control of 2015 and 2016 of layered (PRE/POST) residual herbicides compared to preemergence (PRE) application only.

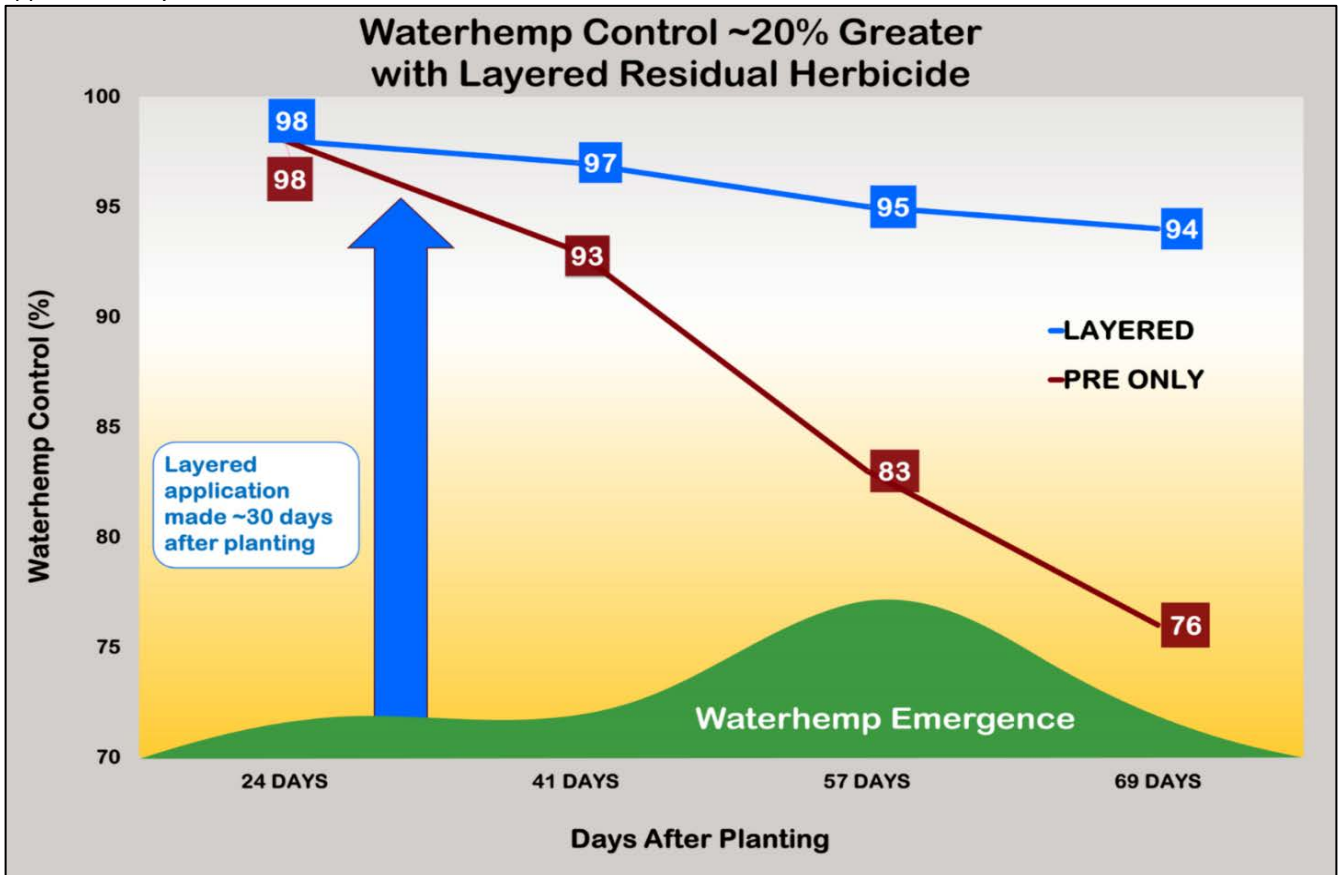




Figure 3. Comparison of weed control in soybean with a single preemergence, May 5, application of Outlook (left and layered applications of Outlook on May 5 and June 8 (right). Top photos taken on July 14, 2015. Bottom photos taken three weeks later on August 6, 2015.

Table 2. Waterhemp and common lambsquarters control and soybean yield with residual herbicides applied either PRE (A) only or layered PRE/POST (A/B) at Rochester, MN in 2015.

Pest Name					Common waterhemp		Common lambsquarters		YIELD 13%	
Rating Date					Sep-29-2015				Oct-13-2015	
No.	Name	Rate	Unit	Code Description	(%) CONTROL				YIELD (bu/A)	
1	SOA 2, 15 DUAL II MAGNUM PURSUIT	1.5 4	pt/a fl oz/a	A A	81	b	92	c	43.1	cd
2	SOA 2, 15 / 15 DUAL II MAGNUM PURSUIT DUAL II MAGNUM	1.5 4 1.0	pt/a fl oz/a pt/a	A A B +/- 30 DAP	95	a	97	ab	48.9	ab
3	SOA 2, 15 OUTLOOK PURSUIT	18 4	fl oz/a fl oz/a	A A	71	c	98	ab	40.3	d
4	SOA 2, 15 / 15 OUTLOOK PURSUIT OUTLOOK	14 4 10	fl oz/a fl oz/a fl oz/a	A A B +/- 30 DAP	94	a	98	ab	51.4	a
5	SOA 2, 15 WARRANT PURSUIT	1.6 4	qt/a fl oz/a	A A	62	d	97	b	32.3	e
6	SOA 2, 15 / 15 WARRANT PURSUIT WARRANT	1.6 4 1.6	qt/a fl oz/a qt/a	A A B +/- 30 DAP	90	a	99	a	46.1	bc
LSD P=.10					6.9		2.3		4.1	

Table 3. Waterhemp and common lambsquarters control and soybean yield with residual herbicides applied either PRE (A) only or layered PRE/POST (A/C) at Rochester, MN in 2016.

Pest Name						Common waterhemp		Common lambsquarters		YIELD @13%		
Rating Date						Sep-26-2016				Oct-14-2016		
No.	Name	Rate	Unit	Code	Description	(%) CONTROL						(bu/A)
1	SOA 15, 2 DUAL II MAGNUM FIRSTRATE	1.5 0.6	pt/a oz/a	A A		76	b	86	ab	45.7	bc	
2	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a oz/a pt/a	A A C	+/- 30 DAP	94	a	92	a	47.7	abc	
3	SOA 15, 2 OUTLOOK FIRSTRATE	18 0.6	fl oz/a oz/a	A A		79	b	82	b	50.3	ab	
4	SOA 15, 2 / 15 OUTLOOK FIRSTRATE OUTLOOK	14 0.6 10	fl oz/a oz/a fl oz/a	A A C	+/- 30 DAP	95	a	83	b	51.8	ab	
5	SOA 15, 2 WARRANT FIRSTRATE	1.6 0.6	qt/a oz/a	A A		79	b	81	b	42.2	c	
6	SOA 15, 2 / 15 WARRANT FIRSTRATE WARRANT	1.6 0.6 1.6	qt/a oz/a qt/a	A A C	+/- 30 DAP	91	a	87	ab	52.9	a	
LSD P=.10 for weed control, LSD P=.20 for yield						7.0		6.5		4.95		

Table 4. Comparison of a PRE Group-15 herbicide followed by three different POST Group-15 application timings (20 DAP, 29 DAP and 44 DAP) for waterhemp control in soybeans at Rochester, MN in 2016.

Pest						Waterhemp species									
Rating Date						Jun-1-2016	Jun-10-2016	Jun-27-2016	Jul-8-2016	Sep-26-2016					
No.	Name	Rate	Unit	Code	Description	(%) CONTROL									
A/B = PRE / POST I 5-4-16 / 5-24-16															
11	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a oz/a pt/a	A A B	+ 20 DAP	98	a	98	a	94	a	93	a	93	a
A/C = PRE / POST II 5-4-16 / 6-2-16															
2	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a oz/a pt/a	A A C	+ 29 DAP	97	b	96	a	93	a	92	a	94	a
A/D = PRE / POST III 5-4-16 / 6-17-16															
12	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a oz/a pt/a	A A D	+ 44 DAP	97	b	93	b	85	b	83	b	83	b
LSD P=.10 for weed ratings						0.9		2.6		2.2		3.5		6.2	

Table 5. Common waterhemp control with preemergence compared to preemergence followed by postemergence herbicides in soybeans in SE MN in 2016.

Pest Code	AMATA						YIELD @13% October 13 (bu/A)		
	Common waterhemp								
Pest Name	May-24	June-1	June-10	June-27	July-8	Sept-26			
Rating Date	($)$ CONTROL								
Treatment	Rate	Appl							
9 SOA 2 CHECK FIRSTRATE	0.6 oz/a	A	0 c	0 f	0 g	0 g	0 g	0 e	28.3 e
A = PRE 5-4-16									
1 SOA 15, 2 DUAL II MAGNUM FIRSTRATE	1.5 pt/a 0.6 oz/a	A A	98 ab	97 bc	90 e	78 f	72 f	76 d	45.7 cd
3 SOA 15, 2 OUTLOOK FIRSTRATE	18 fl oz/a 0.6 oz/a	A A	98 ab	98 a	98 ab	80 f	72 f	79 cd	50.3 abc
5 SOA 15, 2 WARRANT FIRSTRATE	1.6 qt/a 0.6 oz/a	A A	97 ab	95 de	85 f	80 f	80 e	79 cd	42.2 d
7 SOA 14, 2 VALOR SX FIRSTRATE	3 oz/a 0.6 oz/a	A A	99 a	99 a	99 a	98 a	97 ab	98 a	51.8 ab
A/B = PRE / POST I 5-4-16 / 5-24-16 (20 DAP)									
11 SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A B	98 ab	98 ab	98 ab	94 bcd	93 bcd	93 b	51.6 ab
A/C = PRE / POST II 5-4-16 / 6-2-16 (29 DAP)									
2 SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A C	99 a	97 c	96 c	93 cd	92 cd	94 ab	47.7 bcd
4 SOA 15, 2 / 15 OUTLOOK FIRSTRATE OUTLOOK	14 fl oz/a 0.6 oz/a 10 fl oz/a	A A C	98 ab	97 c	98 abc	96 abc	95 abc	95 ab	51.8 ab
6 SOA 15, 2 / 15 WARRANT FIRSTRATE WARRANT	1.6 qt/a 0.6 oz/a 1.6 qt/a	A A C	97 b	95 e	97 bc	91 d	91 d	91 b	52.9 ab
8 SOA 14, 2 / 15 VALOR SX FIRSTRATE DUAL II MAGNUM	3 oz/a 0.6 oz/a 1.0 pt/a	A A C	98 ab	99 a	99 a	97 ab	98 a	98 a	53. a
10 SOA 15, 2 / 15 ZIDUA FIRSTRATE OUTLOOK	2.5 oz/a 0.6 oz/a 18 fl oz/a	A A C	98 ab	96 cd	99 a	94 bcd	93 bcd	93 b	50.6 abc
A/C = PRE / POST III 5-4-16 / 6-17-16 (44 DAP)									
12 SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A D	99 a	97 bc	93 d	85 e	83 e	83 c	48.2 abc
LSD P=.10 for weed ratings, LSD P=.20 for yield			2	1	2	4	4	5	5.8

Table 6. Common lambsquarters control with preemergence compared to preemergence followed by postemergence herbicides in soybeans in SE MN in 2016.

Pest Code Pest Name Rating Date				CHEAL							YIELD @13% October 13 (bu/A)	
				Common lambsquarter								
Trt Treatment Rate Appl				May-24	Jun-1	Jun 10	Jun-27	Jul-8	Sept 26			
				(%) CONTROL								
9	SOA 2 CHECK FIRSTRATE	0.6	oz/a A	0 b	0 c	0 d	0 e	0 f	0 e	28.3	e	
A = PRE 5-4-16												
1	SOA 15, 2 DUAL II MAGNUM FIRSTRATE	1.5 0.6	pt/a A oz/a A	94 a	95 ab	90 bc	86 bc	86 d	86 cd	45.7	cd	
3	SOA 15, 2 OUTLOOK FIRSTRATE	18 0.6	fl oz/a A oz/a A	93 a	96 ab	93 ab	88 bc	86 d	82 d	50.3	abc	
5	SOA 15, 2 WARRANT FIRSTRATE	1.6 0.6	qt/a A oz/a A	94 a	95 b	86 c	80 d	80 e	81 d	42.2	c	
7	SOA 14, 2 VALOR SX FIRSTRATE	3 0.6	oz/a A oz/a A	95 a	97 a	97 a	95 a	95 a	96a a	51.8	ab	
A/B = PRE / POST I 5-4-16 / 5-24-16 (20 DAP)												
11	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a A oz/a A pt/a B	94 a	96 ab	93 ab	89 bc	87 cd	87 bcd	51.6	ab	
A/C = PRE / POST II 5-4-16 / 6-2-16 (29 DAP)												
2	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a A oz/a A pt/a C	93 a	97 ab	94 ab	92 ab	92 abc	92 abc	47.7	bcd	
4	SOA 15, 2 / 15 OUTLOOK FIRSTRATE OUTLOOK	14 0.6 10	fl oz/a A oz/a A fl oz/a C	93 a	95 ab	90 bc	84 cd	83 de	83 d	51.8	ab	
6	SOA 15, 2 / 15 WARRANT FIRSTRATE WARRANT	1.6 0.6 1.6	qt/a A oz/a A qt/a C	92 a	95 b	91 bc	88 bc	87 bcd	87 bcd	52.9	ab	
8	SOA 14, 2 / 15 VALOR SX FIRSTRATE DUAL II MAGNUM	3 0.6 1.0	oz/a A oz/a A pt/a C	95 a	97 ab	95 ab	92 ab	93 ab	93 ab	53.7	a	
10	SOA 15, 2 / 15 ZIDUA FIRSTRATE OUTLOOK	2.5 0.6 18	oz/a A oz/a A fl oz/a C	92 a	95 ab	90 bc	87 bc	87 cd	87 cd	50.6	abc	
A/D = PRE / POST III 5-4-16 / 6-17-16 (44 DAP)												
12	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 0.6 1.0	pt/a A oz/a A pt/a D	94 a	95 ab	92 ab	88 bc	85 de	85 d	48.2	abc	
LSD P=.10 for weed ratings, LSD P=.20 for yield				5	2	6	6	6	6	5.8		

Table 7. Grass control with preemergence compared to preemergence followed by postemergence herbicides in soybeans in SE MN in 2016.

Pest Code				GRASS						YIELD					
Pest Name				Grangea sp.						@13%					
Rating Date				Jun-1		October 13		Jun-27		Jul-8		Sep-26		October 13	
Trt	Treatment	Rate	Appl	(% CONTROL)										(bu/A)	
9	SOA 2 CHECK FIRSTRATE	0.6 oz/a	A	0	c	0	c	0	f	0	e	0	d	28.3	e
A = PRE 5/4/16															
1	SOA 15, 2 DUAL II MAGNUM FIRSTRATE	1.5 pt/a 0.6 oz/a	A A	99	ab	99	a	97	abc	97	ab	97	a	45.7	cd
3	SOA 15, 2 OUTLOOK FIRSTRATE	18 fl oz/a 0.6 oz/a	A A	99	a	99	a	98	ab	98	a	98	a	50.3	abc
5	SOA 15, 2 WARRANT FIRSTRATE	1.6 qt/a 0.6 oz/a	A A	97	b	93	b	91	e	91	d	90	c	42.2	d
7	SOA 14, 2 VALOR SX FIRSTRATE	3 oz/a 0.6 oz/a	A A	97	ab	96	a	92	de	91	d	91	c	51.8	ab
A/B = PRE/POST I 5/4/16 / 5/24/16 (20 DAP)															
11	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A B	99	a	99	a	99	a	99	a	98	a	51.6	ab
A/C = PRE/ POST II 5/4/16 / 6/2/16 (29 DAP)															
2	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A C	99	a	99	a	97	abc	97	ab	96	ab	47.7	bcd
4	SOA 15, 2 / 15 OUTLOOK FIRSTRATE OUTLOOK	14 fl oz/a 0.6 oz/a 10 fl oz/a	A A C	99	a	98	a	98	ab	97	ab	97	a	51.8	ab
6	SOA 15, 2 / 15 WARRANT FIRSTRATE WARRANT	1.6 qt/a 0.6 oz/a 1.6 qt/a	A A C	99	a	98	a	95	bcd	95	bc	93	bc	52.9	ab
8	SOA 14, 2 / 15 VALOR SX FIRSTRATE DUAL II MAGNUM	3 oz/a 0.6 oz/a 1.0 pt/a	A A C	98	ab	97	a	94	cde	93	cd	93	bc	53.7	a
10	SOA 15, 2 / 15 ZIDUA FIRSTRATE OUTLOOK	2.5 oz/a 0.6 oz/a 18 fl oz/a	A A C	99	a	99	a	98	ab	98	a	97	a	50.6	abc
A/D = PRE/POST III 5/4/16 / 6/17/16 (44 DAP)															
12	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A D	99	a	99	a	98	ab	98	a	98	a	48.2	abc
LSD P=.10 for weed ratings, LSD P=.20 for yield				1.8		3.1		3.2		3.0		3.7		5.8	

Table 8. Crop response to layered PRE/POST herbicide programs used to control waterhemp in soybeans in SE MN in 2016.

Pest Code				INJURY				YIELD	
Rating Date				May-24	Jun-1	Jun-10	Jun-27	@13% October 13	
Trt	Treatment	Rate	Appl	Percent Injury (%)				(bu/A)	
9	SOA 2 CHECK FIRSTRATE	0.6 oz/a	A	7	0 b	0 e	0 b	28.3	e
<i>A = PRE 5/4/16</i>									
1	SOA 15, 2 DUAL II MAGNUM FIRSTRATE	1.5 pt/a 0.6 oz/a	A A	10	0 b	0 e	0 b	45.7	cd
3	SOA 15, 2 OUTLOOK FIRSTRATE	18 fl oz/a 0.6 oz/a	A A	12	0 b	0 e	0 b	50.3	abc
5	SOA 15, 2 WARRANT FIRSTRATE	1.6 qt/a 0.6 oz/a	A A	11	0 b	0 e	0 b	42.2	d
7	SOA 14, 2 VALOR SX FIRSTRATE	3 oz/a 0.6 oz/a	A A	10	0 b	0 e	0 b	51.8	ab
<i>A/B = PRE/POST I 5/4/16 / 5/24/16 (20 DAP)</i>									
11	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A B	12	7 a	27 b	0 b	51.6	ab
<i>A/C = PRE/POST II 5/4/16 / 6/2/16 (29 DAP)</i>									
2	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A C	5	0 b	27 b	0 b	47.7	bcd
4	SOA 15, 2 / 15 OUTLOOK FIRSTRATE OUTLOOK	14 fl oz/a 0.6 oz/a 10 fl oz/a	A A C	12	0 b	15 d	0 b	51.8	ab
6	SOA 15, 2 / 15 WARRANT FIRSTRATE WARRANT	1.6 qt/a 0.6 oz/a 1.6 qt/a	A A C	15	0 b	15 d	0 b	52.9	ab
8	SOA 14, 2 / 15 VALOR SX FIRSTRATE DUAL II MAGNUM	3 oz/a 0.6 oz/a 1.0 pt/a	A A C	12	0 b	32 a	0 b	53.7	a
10	SOA 15, 2 / 15 ZIDUA FIRSTRATE OUTLOOK	2.5 oz/a 0.6 oz/a 18 fl oz/a	A A C	10	0 b	18 c	0 b	50.6	abc
<i>A/D = PRE/POST III 5/4/16 / 6/17/16 (44 DAP)</i>									
12	SOA 15, 2 / 15 DUAL II MAGNUM FIRSTRATE DUAL II MAGNUM	1.5 pt/a 0.6 oz/a 1.0 pt/a	A A D	12	0 b	0 e	5 a	48.2	abc
LSD P=.10 for weed ratings, LSD P=.20 for yield				NS	1.2	3.2		5.8	