

Economics of Weed Control Programs for non-GMO Soybean, 2021

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A field trial sponsored by the Michigan Soybean Promotion Committee (MSPC) was conducted in 2021 at the MSU Agronomy Research Farm in Lansing to compare weed control, soybean injury, soybean yield, and economic returns of potential programs in non-GMO (conventional) soybean. Soil-applied (PRE) herbicide programs were designed to provide control of dominant weed species found in Michigan soybean fields. Twenty one different soil-applied (PRE) herbicide programs were applied immediately after soybean planting. The soil-applied herbicide programs were scouted for weed escapes and postemergence (POST) herbicides were applied to control escaped weeds. Treatments were evaluated ~21 and 35 days after planting (DAP). After the 35 DAP evaluation, POST herbicide treatments were selected and sprayed to control escaped weeds. POST herbicides and rates were selected based on the weeds that needed to be controlled. For example, if common ragweed was the escaped weed a herbicide like Flexstar or Cobra was applied. Herbicide rates were adjusted to weed size. Additionally, some POST treatments were applied in separate applications to compare this to one POST application with an increased herbicide rate (i.e., Group 1 herbicide) to overcome potential grass antagonisms. For example, if a Group 14 (Flexstar or Cobra) was applied first we waited 7 d before applying the grass herbicide (Group 1), if the grass herbicide was applied first, we waited 3 d and then applied the broadleaf herbicide. All treatments needed a POST herbicide application; however there was one PRE herbicide that we did not treat with a POST to show the importance of a POST herbicide application this year. Site characteristics and herbicide application timings are described in Table 1. Table 2 describes the herbicide programs evaluated. The maximum soybean yield was 85.7 bu/A and yield loss due to weeds was high. The weedy (untreated) yield was 44.6 bu/A, resulting in a yield loss of 41.1 bu/A (48%). Tables 3 & 4 contain the data for soybean injury, weed control, herbicide program costs, soybean yield, and economic returns.

Table 1. Site description.

Crop	Soybean
Variety	ZFS 2721
Soil Texture	clay loam
Soil pH	7.5
Soil Organic Matter	2.4
Dominant Weeds	ANGR, CHEAL, AMAPO, AMBEL ¹ , ABUTH
Planting Date	May 10
Application Timings:	
PRE	May 10
POST	June 15
POST (+3d)	June 17
POST (+7d)	June 24
Evaluation Times	21 & 35 d after planting 7, 14, & 28 d after POST & at harvest

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMAPO = Powell amaranth, AMBEL = c. ragweed, ABUTH = velvetleaf.

¹The c. ragweed population at this location is ALS-resistant (Group 2).

Table 2. non-GMO soybean herbicide programs evaluated in 2021.

PRE TREATMENT	POST TREATMENT	ABBREVIATED FORM
Boundary (2.4 pt)	Flexstar (1 pt) +Harmony SG (0.125 oz) + COC (1%) + AMS (2.5 lb) fb. SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Boundary fb. Flex + Harm fb. Select (9) (+7d)
BroadAxe XC (32 fl oz)	Flexstar (1 pt) + Perpetuo (6 fl oz) + COC (1%) + AMS (2.5 lb) fb. SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	BroadAxe fb. Flex + Perpetuo fb. Select (9) (+7d)
Sonic (6 oz) + Boundary (1.5 pt)	Flexstar (1 pt) + Harmony SG (0.125 oz) + SelectMax (12 fl oz) + NIS (0.25%) + AMS (2.5 lb)	Sonic + Boundary fb. Flex + Harm + Select (12)
Surveil (3.5 oz) + Metribuzin (6 oz)	Raptor (5 fl oz) + Flexstar (1 pt) + COC (1%) + AMS (2.5 lb)	Surveil + Metri fb. Raptor + Flex
Dimetric Charged (12 fl oz)	Flexstar (1 pt) + Perpetuo (6 fl oz) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Dimet Charged fb. Flex + Perpetuo + Select (12)
Valor EZ (2.5 fl oz) + Prowl H2O (2 pt)	Raptor (5 fl oz) + COC (1%) + AMS (2.5 lb) fb. Flexstar (1 pt) + COC (1%) + AMS (2.5 lb) (+3d)	Valor EZ + Prowl fb. Raptor fb. Flex (+3d)
Fierce EZ (7.5 fl oz)	Raptor (5 fl oz) + Basagran (12.8 fl oz) + Flexstar (1 pt) + COC (1%) + AMS (2.5 lb)	Fierce EZ fb. Raptor + Basa + Flex
Fierce MTZ (16 fl oz)	Raptor (5 fl oz) + Flexstar (1 pt) + COC (1%) + AMS (2.5 lb)	Fierce MTZ fb. Raptor + Flex
Valor XLT (4 oz)	SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) fb. Flexstar (1 pt) + Harmony (0.125 oz) + COC (1%) + AMS (2.5 lb) (+3d)	Valor XLT fb. Select (9) fb. Flex + Harm (+3d)
Valor XLT (4 oz) + Metribuzin (6 oz)	NO POST	Valor XLT + Metri
Authority MTZ (14 oz)	SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) fb. Cobra (10 fl oz) + Perpetuo (6 fl oz) + COC (0.5%) + AMS (2.5 lb) (+3d)	Auth MTZ fb. Select (9) fb. Cobra + Perpetuo (+3d)
Authority Edge (10 fl oz)	Flexstar (1 pt) + COC (0.5%) + AMS (2.5 lb) fb. Harmony SG (0.125 oz) + SelectMax (12 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Auth Edge (10) fb. Flex fb. Harm + Select (12) (+7d)
Authority Edge (8 fl oz) + Metribuzin (6 oz)	Flexstar (1 pt) + Cobra (4 fl oz) + COC (0.5%) + AMS (2.5 lb) fb. Harmony SG (0.125 oz) + SelectMax (12 fl oz) + NIS (0.25%) + AMS (2.5 lb)	Auth Edge (8) + Metri (6) fb. Flex + Cobra fb. Harm + Select (12) (+7d)
Zidua PRO (6 fl oz)	Basagran (1.6 pt) + Flexstar (1 pt) + COC (1%) + AMS (2.5 lb) fb. SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Zidua PRO fb. Basa + Flex fb. Select (9) (+7d)

Valor XLT (2.5 oz) + Valor EZ (1.5 fl oz) + Metribuzin (8 oz)	Marvel (7.25 fl oz) + Flexstar (4 fl oz) + COC (1%) + AMS (2.5 lb) fb. SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Valor XLT + Valor EZ + Metri(8) fb. Marvel + Flex fb. Select (9) (+7d)
Prefix (2 pt) + Metribuzin (6 oz)	Synchrony XP (0.375 oz) + Cobra (10 fl oz) + NIS (0.25%) + AMS (2.5 lb) fb. SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Prefix + Metri (6) fb. Synch XP + Cobra fb. Select (9) (+7d)
Warrant Ultra (50 fl oz) + Metribuzin (6 oz)	Synchrony XP (0.375 oz) + Cobra (10 fl oz) + SelectMax (12 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Warrant Ultra + Metri fb. Synch XP + Cobra fb. Select (12) (+7d)
Matador-S (3 pt)	Cobra (10 fl oz) + COC (0.5%) + AMS (2.5 lb) fb. Harmony SG (0.125 oz) + SelectMax (12 fl oz) + NIS (0.25%) + AMS (2.5 lb) (+7d)	Matador fb. Cobra fb. Harm + Select (12) (+7d)
Shutdown (5 fl oz) + Metricor (5 fl oz)	Ultra Blazer (1.5 pt) + Shadow (8 fl oz) + NIS (0.25%) + AMS (8.5 lb)	Shutdown + Merticor fb. Blazer + Shad
Moccasin II Plus (1 pt) + Shutdown (5 fl oz) + Metricor (5 fl oz)	Ultra Blazer (1.5 pt) + Shadow (8 fl oz) + NIS (0.25%) + AMS (8.5 lb)	Moc II Plus + Shutdown + Merticor fb. Blazer + Shad
Upstage (21 fl oz) + Shutdown (5 fl oz) + Metricor (5 fl oz)	Ultra Blazer (1.5 pt) + Shadow (8 fl oz) + NIS (0.25%) + AMS (8.5 lb)	Upstage + Shutdown + Merticor fb. Blazer + Shad

Table 3. Weed control at the time of POST herbicide application¹.

PRE TREATMENT	Weed control (at POST – 35 DAP)				
	ANGR	CHEAL	AMAPO	AMBEL ²	ABUTH
	% control				
Boundary (2.4 pt)	82	80	100	71	80
BroadAxe XC (32 fl oz)	87	100	100	68	83
Sonic (6 oz) + Boundary (1.5 pt)	78	90	100	80	94
Surveil (3.5 oz) + Metribuzin (6 oz)	87	94	100	90	100
Dimetric Charged (12 fl oz)	75	90	100	75	81
Valor EZ (2.5 fl oz) + Prowl H2O (2 pt)	85	93	100	78	93
Fierce EZ (7.5 fl oz)	83	84	100	79	86
Fierce MTZ (16 fl oz)	80	90	100	76	96
Valor XLT (4 oz)	65	93	100	68	81
Valor XLT (4 oz) + Metribuzin (6 oz)	62	92	100	66	86
Authority MTZ (14 oz)	10	90	100	58	65
Authority Edge (10 fl oz)	81	90	100	70	86
Authority Edge (8 fl oz) + Metribuzin (6 oz)	76	100	100	73	80
Zidua PRO (6 fl oz)	73	90	100	76	84
Valor XLT (2.5 oz) + Valor EZ (1.5 fl oz) + Metribuzin (8 oz)	70	90	100	81	94
Prefix (2 pt) + Metribuzin (6 oz)	84	92	100	80	65
Warrant Ultra (50 fl oz) + Metribuzin (6 oz)	86	90	100	80	58
Matador-S (3 pt)	90	94	100	78	100
Shutdown (5 fl oz) + Metricor (5 fl oz)	61	89	100	62	80
Moccasin II Plus (1 pt) + Shutdown (5 fl oz) + Metricor (5 fl oz)	88	100	100	70	79
Upstage (21 fl oz) + Shutdown (5 fl oz) + Metricor (5 fl oz)	88	93	100	79	96

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMAPO = Powell amaranth, AMBEL = c. ragweed, ABUTH = velvetleaf.

¹POST herbicide selection was based on weed control that was less than 90% for the different weed species.

²The common ragweed population at this location is resistant to the Group 2 (ALS-inhibiting) herbicides.

Table 4. Soybean injury, weed control, program costs, soybean yield, and economic returns for non-GMO herbicide programs, 2021.

Herbicide Programs ²	Soybean Injury		Prior to harvest (118 d after POST) ¹				All Weeds (≥90%)	Costs ³ (\$/A)	Yield (bu/A)	Economic Returns ⁴ (\$/A)
	21 DAP	7 DAT	ANGR	CHEAL	AMBEL	ABUTH				
	(%)	(%)	% control							
Boundary fb. Flex + Harm fb. Select (9) (+7d)	0	14	99	96	94	96	YES	\$69.96	80.2*	\$1,133*
BroadAxe fb. Flex + Perpetuo fb. Select (9) (+7d)	0	23*	100	99	96	99	YES	\$87.17	73.1	\$1,009
Sonic + Boundary fb. Flex + Harm + Select (12)	0	26*	100	100	96	100	YES	\$79.79	75.7	\$1,056
Surveil + Metri fb. Raptor + Flex	0	20	98	100	100	100	YES	\$78.65	73.7	\$1,027
Dimet Charged fb. Flex + Perpetuo + Select (12)	0	20	100	95	100	100	YES	\$69.49	81.2*	\$1,149*
Valor EZ + Prowl fb. Raptor fb. Flex (+3d)	0	16	100	100	100	100	YES	\$84.99	77.4*	\$1,076
Fierce EZ fb. Raptor + Basa + Flex	0	23*	100	100	99	100	YES	\$87.82	78.9*	\$1,096*
Fierce MTZ fb. Raptor + Flex	0	19	100	97	98	100	YES	\$78.31	81.1*	\$1,138*
Valor XLT fb. Select (9) fb. Flex + Harm (+3d)	0	20	100	100	99	95	YES	\$60.63	81.3*	\$1,159*
Valor XLT + Metri (PRE only)	0	0	0	100	0	73	NO	\$29.73	55.0	\$795
Auth MTZ fb. Select (9) fb. Cobra + Perpetuo (+3d)	0	26*	100	95	98	100	YES	\$104.21**	76.3	\$1,040
Auth Edge (10) fb. Flex fb. Harm + Select (12) (+7d)	0	16	100	100	100	100	YES	\$87.86	80.6*	\$1,121*
Auth Edge (8) + Metri (6) fb. Flex + Cobra fb. Harm + Select (12) (+7d)	0	30*	100	100	99	98	YES	\$93.42	79.2*	\$1,095*
Zidua PRO fb. Basa + Flex fb. Select (9) (+7d)	0	23*	100	92	96	95	YES	\$84.98	74.4	\$1,031
Valor XLT + Valor EZ + Metri (8) fb. Marvel + Flex fb. Select (9)	0	15	99	98	91	100	YES	\$74.65	85.7**	\$1,211**
Prefix + Metri (6) fb. Synch XP + Cobra fb. Select (9)	0	28*	100	93	98	94	YES	\$75.93	80.5*	\$1,132*
Warrant Ultra + Metri (6) fb. Synch XP + Cobra fb. Select (12) (+7d)	0	26*	98	96	95	91	YES	\$75.28	79.9*	\$1,123*
Matador S fb. Cobra fb. Harm + Select (12) (+7d)	0	28*	99	100	95	100	YES	\$80.29	73.6	\$1,024
Shutdown + Metricor (5) fb. Blazer + Shadow	0	20	100	100	68	90	NO	\$46.88	75.0	\$1,078
Moc II Plus + Shut + Metricor (5) fb. Blazer + Shad	0	23*	100	100	73	88	NO	\$53.13	75.2	\$1,075
Upstage + Shut + Metricor (5) fb. Blazer + Shadow	0	18	98	100	82	100	NO	\$60.77	77.6*	\$1,103*
<i>Untreated</i>	0	0	0	0	0	0	NO	---	44.6	\$669

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMAPO = Powell amaranth, AMBEL = c. ragweed, ABUTH = velvetleaf, fb. = followed by.

¹Control of AMAPO with all herbicide programs was 100%.

²Many herbicide programs have long rotation restrictions to sensitive crops. Consult the Table 12 in the MSU Weed Control Guide for Field Crops (E0434) or the herbicide label for crop rotation restrictions

³Herbicide costs = avg. of price lists; App. cost = \$9.00/A; seeding rate = 155,000 seeds/A. Weed control costs = Herbicide \$ + Additive \$ + Application \$.

⁴Crop selling price = \$13.50/bu + non-GMO premium \$1.50/bu (December 2020). Economic return = (Yield x Price) – Weed Control Costs.

** Highest yielding and highest economic returns. * Values are not significantly different from the highest value within that column.



General Observations and Interpretation:

Each year weather can impact outcomes of the various herbicide programs examined in the non-GMO soybean study. Rainfall soon after the PRE herbicide application can have a major effect on weed control. This year conditions were extremely dry with only 0.05-inch of precipitation within two weeks after planting. In fact, there was less than one inch of rainfall within the first 30 days of the herbicide application. While weed control was not excellent with the PRE herbicides, they did suppress weeds for approximately 35 days. Table 3 provides information on weed control from the PRE herbicide treatments at the time of POST. The main weeds that escaped control from the PRE treatments were annual grasses and common ragweed. Common lambsquarters and velvetleaf also escaped control in several treatments. Average weed heights were 3-4 inches tall at the time of POST application. POST herbicide treatments were chosen based on the weeds that needed to be controlled. Some POST treatments were separated into two applications, applied either 3 or 7 days after the initial POST application. This was to demonstrate ways to alleviate POST grass antagonism. To demonstrate how important a POST herbicide application was this year, we did not apply a POST herbicide to one of the PRE treatments. Soybean injury from POST treatments ranged from 14-30%, 7 DAT (Table 4). Cobra applied at 10 fl oz or Cobra (4 fl oz) + Flexstar (1 pt) followed by Harmony GT caused the greatest injury. By 28 DAT soybean injury was less than 10%. All but five PRE followed by POST treatments provided greater than 90% control of all weed species, 28 days after the POST application. Common ragweed and velvetleaf control by these treatments ranged from 78-88%. By harvest, all but three PRE followed by POST programs resulted in greater than 90% control. These treatments all included Ultra Blazer for common ragweed control which resulted in 68 to 82%. Annual grass control was greater than 90% at harvest with all PRE followed by POST treatments. There was a significant range in costs of the herbicide programs (Table 4). Herbicide program costs including application costs of \$9 per acre, for PRE followed by POST treatments ranged from \$46.88 to \$104.21 per acre. These costs were used to determine the economic returns at the end of the growing season. Due to adequate rainfall during soybean pod fill, yields were 33% higher than last year. Yield for the different herbicide PRE followed by POST programs was ranged from 73.1 to 85.7 bu/A (Table 4). If a POST herbicide program was not applied yield was 30 bu/A lower than the highest yielding program, a 35% yield reduction. Twelve of the 20 PRE fb. POST herbicide programs evaluated ranked amongst the highest yielding. All of the highest yielding programs ranked amongst programs with the highest economic returns, with the exception of one. This program was amongst one of the more expensive programs, but not the most expensive that had high yields. This year it was extremely important to have a POST herbicide program due to the late season rains. Of the 10 programs that separated POST herbicide application into two application times (+3d or +7d), five were amongst the highest yielding and highest economic returns, even though some of these programs included an additional application cost. In many cases there was not a detriment to splitting the POST program. In general, it is important to plan on a two-pass program (PRE fb. POST) when growing non-GMO soybean. Throughout the years these programs have consistently provided better weed control, yield, and economic returns, even with the added herbicide and application cost.