MSU Weed Science

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Economics of Weed Control Programs for non-GMO Soybean, 2017

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A field trial sponsored by the Michigan Soybean Promotion Committee (MSPC) was conducted in 2017 at the MSU Agronomy Research Farm in E. 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-five 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 for crop injury and weed control ~21 and 34 days after planting (DAP). At 34 DAP plots were scouted for POST herbicide treatments. Postemergence (POST) herbicides were chosen based on weeds that were no longer controlled from the PRE applications. POST herbicides and applications 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. Site characteristics and herbicide application timings are described in Table 1. Table 2 describes the herbicide programs evaluated. The maximum soybean yield was 59.6 bu/A and yield loss due to weeds was extremely high. The weedy (untreated) yield was 14.4 bu/A, resulting in a yield loss of 45.2 bu/A (75%). Table 3 contains the data for soybean injury, weed control, herbicide program costs, soybean yield, and economic returns.

Table 1. Site description.

Crop	Soybean
Variety	ZFS 1326
Soil Texture	Sandy loam
Soil pH	6.7
Soil Organic Matter	2.4
Dominant Weeds	ANGR, CHEAL, AMBEL[1], ABUTH, SINAR
Planting Date	May 9
Application Timings:	
PRE	May 9
POST	June 13
Evaluation Times	Soybean injury – 21 d after planting & 7, 14, & 28 d after POST Weed control prior to harvest (56 d after POST)

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMBEL = c. ragweed, ABUTH = velvetleaf, SINAR = wild mustard.
[1]The c. ragweed population at this location is ALS-resistant (Group 2).

Table 2. non-GMO soybean herbicide programs evaluated in 2017.

PRE TREATMENT	POST TREATMENT	ABBREVIATED FORM
Metribuzin (6 oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Metri (6) fb. Flex+Select (12)
Boundary (1.8 pt)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)	Boundary (1.8) fb. Flex+Select (9)
Boundary (2.4 pt)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)	Boundary (2.4) fb. Flex+Select (9)
Authority Elite/BroadAxe (32 fl oz)	Flexstar (1 pt) + SelectMax (12 oz) + COC (1%) + AMS (2.5 lb)	Auth Elite/BroadAxe fb. Flex+Select (12)
Authority MTZ (14 oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Auth MTZ fb. Flex+Select (12)
Authority MTZ (14 oz) + Command (21 fl oz)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)	Auth MTZ+Comm fb. Flex+Select (9)
Authority First (5 oz) + Command (21 fl oz)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)	Auth First+Comm fb. Flex+Select (9)
Sonic (6 oz) + Boundary (1.5 pt)	Cobra (8 fl oz) + SelectMax (12 fl oz) + COC (0.5%) + AMS (2.5 lb)	Sonic+Bound (1.5) fb. Cobra+Select (12)
Valor (2.5 oz) + Prowl H2O (2 pt)	Harmony (0.125 oz) + Cobra (8 fl oz) + Select Max (12 fl oz) + NIS (0.25%)	Valor(2.5)+Prowl fb. Harm+Cobra+Select (12)
Fierce (3 oz)	Ultra Blazer (1.5 pt) + Select Max (9 fl oz) + NIS (0.25%)	Fierce fb. Blazer+Select (9)
Fierce (3 oz) + Metribuzin (6 oz)	Cobra (8 fl oz) + SelectMax (9 fl oz) + COC (0.5%) + AMS (2.5 lb)	Fierce+Metri fb. Cobra+Select (9)
Authority MAXX (6.5 oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Auth MX (6.5) fb. Flex+Select (12)
Rowel FX (3 oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS 2.5 lb)	Rowel fb. Flex+Select (12)
Valor XLT (2 oz) + Valor (1.5 oz) + Metribuzin (6 oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Valor XLT+Valor+Metri fb. Flex+Select (12)
Valor XLT (2 oz) + Valor (1.5 oz) + Boundary (1.8 pt)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)	Valor XLT+Valor+Bound fb. Flex+Select (9)
Afforia (2.5 oz) + Metribuzin (5 oz)	Synchrony (0.375 oz) + Assure II (8 fl oz) + NIS (0.25%)	Afforia+Metri (5) fb. Synch+Assure II
Trivence (8 oz)	Synchrony (0.375 oz) + Assure II (8 fl oz) + NIS (0.25%)	Trivence fb. Synch+Assure II
Trivence (8 oz)	Ultra Blazer (1.5 pt) + SelectMax (12 fl oz) + NIS (0.25%)	Trivence fb. Blazer+Select (12)
Prefix (2 pt) + Metribuzin (6 oz)	Cobra (8 fl oz) + SelectMax (9 fl oz) + COC (0.5%) + AMS (2.5 lb)	Prefix+Metri fb. Cobra+Select (9)
Warrant Ultra (50 fl oz) + Metribuzin (6 oz)	Cobra (8 fl oz) + SelectMax (9 fl oz) + COC (0.5%) + AMS (2.5 lb)	Warr Ult + Metri fb. Cobra+Select (9)
Zidua PRO (6 fl oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Zidua PRO fb. Flex+Select (12)
Authority MTZ (14 oz)	Marvel (7.25 fl oz) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Auth MTZ fb. Marvel+Select (12)
Authority MTZ (14 oz)	Anthem MAXX (3 fl oz) + Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Auth MTZ fb. Anth MX+Flex+Select (12)
Anthem MAXX (3.25 fl oz)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb)	Anth MX (3.25) fb. Flex+Select (12)
Authority MAXX (5 oz)	Synchrony (0.375 oz) + Anthem MAXX (3 oz) + SelectMax (12 fl oz) + NIS (0.25%)	Auth MX (5) fb. Synch+Anth MX+Select (12)

Table 3. Soybean injury, weed control, program costs, soybean yield, and economic returns for non-GMO herbicide programs, 2017.

Herbicide Programs[3]	Soybean injury		ANGR	CHEAL	AMBEL	ABUTH	SINAR				Economic
	21 DAP	14 DAT	Prior to harvest (56 d after POST)					All Weeds	Costs[1]	Yield	Returns[2]
	(%)	(%)	% control					(≥80%)	($/A)	(bu/A)	($/A)
Metri (6) fb. Flex+Select (12)	1	**9**	**91**	**82**	**100**	**98**	**100**	**YES**	$39.97	50.5	**$490.55***
Boundary (1.8) fb. Flex+Select (9)	**8**	**10**	**98**	**82**	**100**	**95**	**100**	**YES**	$51.75	**55.7***	**$533.10***
Boundary (2.4) fb. Flex+Select (9)	**18**	**12**	**100**	**98**	**100**	**100**	**100**	**YES**	$57.98	50.8	**$475.42***
Auth Elite/BroadAxe fb. Flex+Select (12)	**14**	**14**	**100**	**100**	**80**	**90**	**100**	**YES**	$65.95	51.2	**$467.65***
Auth MTZ fb. Flex+Select (12)	1	**10**	**100**	**94**	**96**	**98**	**100**	**YES**	$56.61	**57.1***	**$542.94****
Auth MTZ+Comm fb. Flex+Select (9)	0	**10**	**100**	**95**	**100**	**100**	**100**	**YES**	$76.64	**56.5***	**$516.61***
Auth First+Comm fb. Flex+Select (9)	0	**10**	**100**	**96**	**93**	**100**	**100**	**YES**	$80.63	**52.7***	**$472.72***
Sonic+Bound (1.5) fb. Cobra+Select (12)	**11**	**14**	**95**	**100**	**95**	**100**	**100**	**YES**	$86.61	**59.6****	**$539.19***
Valor(2.5)+Prowl fb. Harm+Cobra+Select (12)	**16**	**28**	**81**	78	70	**98**	**100**	NO	$64.63	**55.3***	**$516.02***
Fierce fb. Blazer+Select (9)	**17**	**14**	**97**	77	74	**100**	**100**	NO	$61.08	49.0	$453.42
Fierce+Metri fb. Cobra+Select (9)	**21**	**14**	**98**	**87**	**100**	**100**	**100**	**YES**	$64.53	47.4	$433.17
Auth MX (6.5) fb. Flex+Select (12)	1	**12**	**99**	**96**	**91**	**98**	**100**	**YES**	$59.36	50.5	**$470.89***
Rowel fb. Flex+Select (12)	**7**	**11**	**95**	**100**	**99**	**100**	**100**	**YES**	$49.72	52.0	**$496.28***
Valor XLT+Valor+Metri fb. Flex+Select (12)	**9**	**11**	**100**	**95**	**100**	**100**	**100**	**YES**	$56.64	**56.4***	**$535.56***
Valor XLT+Valor+Bound fb. Flex+Select (9)[4]	**31**	**13**	**100**	**97**	**100**	**100**	**100**	**YES**	$68.42	**53.0***	**$488.08***
Afforia+Metri (5) fb. Synch+Assure II	**14**	**10**	**91**	**100**	40	**100**	**100**	NO	$43.33	34.5	$318.92
Trivence fb. Synch+Assure II	**11**	**12**	**86**	**100**	45	**98**	**100**	NO	$45.71	38.1	$354.34
Trivence fb. Blazer+Select (12)	**14**	**16**	**93**	**100**	71	**100**	**100**	NO	$61.45	**53.8***	**$503.45***
Prefix+Metri fb. Cobra+Select (9)	**20**	**12**	**99**	**95**	**91**	**96**	**100**	**YES**	$55.21	**56.5***	**$538.04***
Warr Ult + Metri fb. Cobra+Select (9)	**8**	**14**	**100**	**83**	**88**	**89**	**100**	**YES**	$63.20	**55.6***	**$520.60***
Zidua PRO fb. Flex+Select (12)	1	**10**	**99**	**96**	**94**	**100**	**100**	**YES**	$56.40	**52.4***	**$493.80***
Auth MTZ fb. Marvel+Select (12)	1	**15**	**90**	**100**	62	**100**	**100**	**YES**	$58.19	**53.0***	**$498.31***
Auth MTZ fb. Anth MX+Flex+Select (12)	1	**15**	**98**	**97**	**95**	**100**	**100**	**YES**	$73.70	**55.8***	**$512.20***
Anth MX (3.25) fb. Flex+Select (12)	1	**10**	**86**	63	**86**	**90**	**100**	NO	$53.84	48.9	$459.61
Auth MX (5) fb. Synch+Anth MX+Select (12)	0	**17**	**100**	**100**	5	**100**	**100**	NO	$75.10	26.5	$203.15
Untreated	0	0	0	0	0	0	0	NO	---	14.4	$151.20

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMBEL = c. ragweed, ABUTH = velvetleaf, SINAR = wild mustard, fb. = followed by.
** Highest yielding and highest economic returns. * Values are not significantly different from the highest value within that column.

[1] Herbicide costs = avg. of price lists; App. cost = $7.50/A; seeding rate = 155,000 seeds/A. Weed control costs = Herbicide $ + Additive $ + Application $.
[2] Crop selling price = $9.25/bu + non-GMO premium $1.25/bu (December 2017). Economic return = (Yield x Price) – Weed Control Costs.
[3] Many herbicide programs have long rotation restrictions to more sensitive crops, i.e., sugarbeet, alfalfa, potatoes, etc. Consult the Table 12 in the MSU Weed Control Guide for Field Crops (E-434) or the herbicide label for crop rotation restrictions. The use rates of Fierce XLT and Trivence exceed the rates that should be used on a soil with a pH of 7.2. I
[4] Due to the restriction and interaction of applying Valor with the Group 15 herbicide (s-metolachlor) in Boundary this program should not be applied due to excessive crop injury.

General Observations and Interpretation:

Each year weather has a major impact on the overall outcomes of the various herbicide programs for this study. This year early in the growing season there was 1.1-inches of rain within two weeks of planting and the soil-applied (PRE) herbicide applications. This rainfall provided initial incorporation of the PRE herbicides and helped manage some of the smaller seeded broadleaf weeds. Soybean injury was dependent on the herbicides applied. In general 21 DAP, soybean injury was greatest from higher rates of Metribuzin in combination with various herbicides, premixtures that contained fomesafen (Warrant Ultra or Prefix) or flumioxazin (Valor) combinations. The highest injury was from the combination of Valor XLT with Boundary, which is not labeled due to the restrictions of combining flumioxazin with s-metolachlor. Even with this combination causing 30% soybean injury 21 DAP, it ultimately did not affect yield. At the time of the POST herbicide treatments only eight treatments had greater than 90% annual grass control and none of the treatments exceeded 90% common ragweed control. However, there were some initial differences in control of common ragweed. Fierce + Metribuzin provided the greatest common ragweed control (86%) and Anthem MAXX (40%) and Authority Elite/BroadAxe (47%) provided the least control. Overall common lambsquarters and wild mustard control was greater than 90% with all soil-applied herbicides 35 DAP with the exception of Anthem MAXX (70-78%). All POST treatments contained either Assure II or SelectMax to control annual grasses and Flexstar, Cobra, Ultra Blazer, or Marvel was used to control common ragweed. Treatments that relied on Synchrony (Group 2, ALS-inhibitor) for common ragweed control were not effective, since the common ragweed population at this location was resistant to ALS-inhibitors. The addition of Anthem MAXX or Marvel which contain Cadet did not improve control. Treatments that contained Ultra Blazer were also not as effective as Flexstar or in most cases Cobra for common ragweed control. The total cost of the programs ranged from $39.97 to $86.61 (herbicide + application costs). All but seven of the 25 treatments provided greater than 80% control of all the weeds present. These treatments included either Flexstar or Cobra for POST common ragweed control and Select Max for POST grass control. The only exception was when Harmony was added to the Cobra + Select Max for common lambsquarters control and the adjuvant was a non-ionic surfactant. The use of a non-ionic surfactant reduced the Cobra activity on common ragweed, but a crop oil concentrate cannot be used with this tank-mixture due to excessive soybean injury from this mixture. Soybean yield ranged from 26.5 to 59.6 bu/A for all herbicide treatments. All but 11 of these programs were amongst the highest yielding. All of the higher yielding programs were amongst the programs with the highest economic returns. There were five additional programs that were not amongst the highest yielding that were similar to the programs with the highest economic returns for a total of 19 of the 25 programs examined. Yield was more of a factor for economic returns than herbicide program costs. In fact, the highest priced herbicide program resulted in the second highest economic return numerically. Yield appeared to be mostly affected by poor common ragweed and common lambsquarters control. Our recommendation when growing non-GMO soybean is to plan on a two-pass program (PRE fb. POST). These programs have consistently provided better weed control, yield, and economic returns, even with the added herbicide and application cost.