Economics of Weed Control Programs for non-GMO Soybean, 2022
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   A field trial sponsored by the Michigan Soybean Promotion Committee (MSPC) was conducted in 2022 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-two 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. Not all treatments needed a POST herbicide application 35 DAP. All treatments were evaluated one week after the POST application and treatments that had escapes received a late-POST (LPOS) application. There were six PRE treatments that did not need a POST herbicide application. Site characteristics and herbicide application timings are described in Table 1. Table 2 describes the herbicide programs evaluated. The maximum soybean yield was 77.6 bu/A and yield loss due to weeds was high. The weedy (untreated) yield was 21.2 bu/A, resulting in a yield loss of 56.4 bu/A (73%). 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 2221
Soil Texture	clay loam
Soil pH	6.3
Soil Organic Matter	3.3
Dominant Weeds	ANGR, CHEAL, AMAPO, AMBEL[1], ABUTH, SINAR
Planting Date	May 17
Application Timings:	
PRE	May 17
POST	June 21
LPOS	June 28
Evaluation Times	21 & 35 d after planting
	7 d after POST & 7 and 28 d after LPOS

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

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1

Table 2. non-GMO soybean herbicide programs evaluated in 2022.

PRE TREATMENT	POST TREATMENT	ABBREVIATED FORM
Boundary (2.4 pt)	Flexstar (1 pt) + COC (1%) + AMS (2.5 lb) (LP)	Boundary fb. Flexstar (LP)
BroadAxe XC (32 fl oz)	Cobra (10 fl oz) + COC (0.5%) + AMS (2.5 lb) (P)	BroadAxe fb. Cobra (P)
Sonic (6 oz) + Boundary (1.5 pt)	SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (LP)	Sonic + Boundary fb. Select (9) (LP)
Surveil (3.5 oz) + Metribuzin (6 oz)	SelectMax (9 fl oz) + NIS (0.25%) + AMS (2.5 lb) (P)	Surveil + Metri (6) fb. Select (9) (P)
Dimetric Charged (12 fl oz)	Flexstar (1 pt) + Harmony SG (0.125 oz) + SelectMax (12 fl oz) + NIS (0.25%) + AMS (2.5 lb) (P)	Dimet Charg fb. Flex + Harm + Select (12) (P)
Valor EZ (2.5 fl oz) + Prowl H2O (2 pt)	Flexstar (1 pt) + SelectMax (12 fl oz) + COC (1%) + AMS (2.5 lb) (P)	Valor EZ + Prowl fb. Flex + Select (12) (P)
Fierce EZ (7.5 fl oz)	Cobra (10 fl oz) + COC (0.5%) + AMS (2.5 lb) (P)	Fierce EZ fb. Cobra (P)
Fierce MTZ (16 fl oz)	NO POST	Fierce MTZ
Fierce XLT (4 oz)	Cobra (10 fl oz) + SelectMax (12 fl oz) + COC (0.5%) + AMS (2.5 lb) (P)	Fierce XLT fb. Cobra + Select (12) (P)
Tendovo (2.35 qt)	NO POST	Tendovo
Authority MTZ (16 oz)	Flexstar (1 pt) + Fusilade DX (12 fl oz) + COC (1%) (P)	Auth MTZ fb. Flex + Fusilade (P)
Authority Edge (9 fl oz)	Flexstar (1 pt) + COC (1%) + AMS (2.5 lb) (P)	Auth Edge (10) fb. Flexstar (P)
Authority Edge (7 fl oz) + Metribuzin (6 oz)	Marvel (7.25 fl oz) + COC (1%) + AMS (2.5 lb) (P)	Auth Edge + Metri (6) fb. Marvel (P)
Zidua PRO (6 fl oz)	NO POST	Zidua PRO
Zidua PRO (6 fl oz) + Metribuzin (6 oz)	NO POST	Zidua PRO + Metri (6)
Valor XLT (2.5 oz) + Valor EZ (1.5 fl oz) + Metribuzin (8 oz)	Assure II (7 fl oz) + COC (1%) + AMS (2.5 lb) (LP)	Valor XLT+Valor EZ+Metri (8) fb. Assure (LP)
Prefix (2 pt) + Metribuzin (6 oz)	Perpetuo (6 fl oz) + COC (1%) + AMS (2.5 lb) (LP)	Prefix + Metri (6) fb. Perpetuo (LP)
Warrant Ultra (50 fl oz) + Metribuzin (6 oz)	Marvel (7.25 fl oz) + COC (1%) + AMS (2.5 lb) (LP)	Warrant Ultra + Metri (6) fb. Marvel (LP)
Matadador-S (3 pt)	Flexstar (1 pt) + COC (1%) + AMS (2.5 lb) (LP)	Matador fb. Flexstar (LP)
Up-Stage (21 fl oz) + Preview 2.1 (25 fl oz)	NO POST	Up-Stage + Preview
Preview 2.1 (25 fl oz)	Ultra Blazer (24 fl oz) + COC (2 pt) (P) fb. Shadow (8 fl oz) + COC (2 pt) (LP)	Preview fb. U Blazer (P) fb. Shadow (LP)
Up-Stage (21 fl oz) + Moccasin MTZ (42 fl oz)	NO POST	Up-Stage + Moccasin MTZ

Table 3. Weed control at the time of POST herbicide application[1].

PRE TREATMENT	Weed control (at POST – 35 DAP)					
	ANGR	CHEAL	AMAPO	AMBEL[2]	ABUTH	SINAR
			% control			
Boundary fb. Flexstar (LP)	98	100	100	93	97	100
BroadAxe fb. Cobra (P)	100	100	100	97	99	100
Sonic + Boundary fb. Select (9) (LP)	99	100	100	98	100	100
Surveil + Metri (6) fb. Select (9) (P)	84	100	100	98	100	100
Dimet Charg fb. Flex + Harm + Select (12) (P)	86	96	100	98	95	100
Valor EZ + Prowl fb. Flex + Select (12) (P)	95	98	100	100	100	100
Fierce EZ fb. Cobra (P)	95	99	100	97	97	100
Fierce MTZ	99	100	100	99	99	100
Fierce XLT fb. Cobra + Select (12) (P)	89	100	100	100	100	100
Tendovo	100	100	100	98	100	100
Auth MTZ fb. Flex + Fusilade (P)	78	100	100	82	99	100
Auth Edge (10) fb. Flexstar (P)	100	100	100	84	100	100
Auth Edge + Metri (6) fb. Marvel (P)	96	100	100	86	95	100
Zidua PRO	94	100	100	99	100	100
Zidua PRO + Metri (6)	100	100	100	100	100	100
Valor XLT+Valor EZ+Metri (8) fb. Assure (LP)	90	100	100	98	100	100
Prefix + Metri (6) fb. Perpetuo (LP)	99	100	100	100	95	100
Warrant Ultra + Metri (6) fb. Marvel (LP)	98	100	100	96	92	100
Matador fb. Flexstar (LP)	96	100	100	94	100	100
Up-Stage + Preview	100	100	100	100	100	100
Preview fb. U Blazer (P) fb. Shadow (LP)	89	100	100	95	100	100
Up-Stage + Moccasin MTZ	100	100	100	100	100	100

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMAPO = Powell amaranth, AMBEL[2] = c. ragweed, ABUTH = velvetleaf, SINAR = wild mustard, P = POST, LP = Late POST.

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

[2]The 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, 2022.

Herbicide Programs[2]	Soybean Injury		Prior to harvest (28 d after LPOS)[1]							Economic
	35 DAP	7 DAT	ANGR	CHEAL	AMBEL	ABUTH	All Weeds	Costs[3]	Yield	Returns[4]
	(%)	(%)	———————— % control ————————				(≥90%)	($/A)	(bu/A)	($/A)
Boundary fb. Flexstar (LP)	3	0	**99**	**100**	**100**	98	YES	$55.14	**72.6***	**$1,146***
BroadAxe fb. Cobra (P)	4	**21**	94	**100**	94	**100**	YES	$64.36	69.1	$1,079
Sonic + Boundary fb. Select (9) (LP)	3	0	**100**	**100**	91	**100**	YES	$71.82	**77.6****	**$1,212****
Surveil + Metri (6) fb. Select (9) (P)	**9**	2	99	**100**	95	**100**	YES	$59.79	70.4	$1,106
Dimet Charg fb. Flex + Harm + Select (12) (P)	**7**	**27**	99	**100**	**100**	96	YES	$61.03	70.0	$1,098
Valor EZ + Prowl fb. Flex + Select (12) (P)	**8**	**16**	99	95	**100**	**100**	YES	$66.43	**76.1***	**$1,193***
Fierce EZ fb. Cobra (P)	**6**	**20**	89	96	97	**100**	NO	$71.47	68.6	$1,064
Fierce MTZ	**11**	2	97	**100**	94	96	YES	$40.24	**75.5***	**$1,209***
Fierce XLT fb. Cobra + Select (12) (P)	**6**	**18**	**100**	**100**	**100**	**100**	YES	$76.61	**73.1***	**$1,134***
Tendovo	3	0	**100**	**100**	**100**	**100**	YES	$51.34	**75.5***	**$1,198***
Auth MTZ fb. Flex + Fusilade (P)	3	**16**	95	**100**	93	**100**	YES	**$83.42****	**72.1***	**$1,110***
Auth Edge (10) fb. Flexstar (P)	2	**12**	95	**100**	**100**	**100**	YES	$69.86	**72.8***	**$1,135***
Auth Edge + Metri (6) fb. Marvel (P)	1	**18**	99	**100**	99	**100**	YES	$69.69	70.6	$1,099
Zidua PRO	**7**	1	**91**	**100**	92	**100**	YES	$35.64	70.5	**$1,131***
Zidua PRO + Metri (6)	**7**	3	**100**	**100**	**100**	97	YES	$42.39	**74.4***	**$1,189***
Valor XLT + Valor EZ + Metri (8) fb. Assure (LP)	**15**	**12**	83	**100**	93	**100**	NO	$53.59	68.8	$1,085
Prefix + Metri (6) fb. Perpetuo (LP)	**4**	0	**100**	**100**	**100**	**100**	YES	$61.21	**73.0***	**$1,147***
Warrant Ultra + Metri (6) fb. Marvel (LP)	1	0	**97**	**100**	**100**	**100**	YES	$61.69	70.7	**$1,108***
Matador fb. Flexstar (LP)	3	0	**100**	**100**	**100**	**100**	YES	$55.53	**72.7***	**$1,148***
Up-Stage + Preview	1	0	**100**	**100**	**100**	**100**	YES	$40.60	**71.3***	**$1,139***
Preview fb. U Blazer (P) fb. Shadow (LP)	0	**20**	**100**	**100**	96	**100**	YES	$77.80	68.0	$1,048
Up-Stage + Moccasin MTZ	3	0	**98**	**100**	**100**	**100**	YES	$41.45	**73.5***	**$1,175***
Untreated	0	0	0	0	0	0	NO	---	21.2	$351

Abbreviations: ANGR = giant foxtail, CHEAL = c. lambsquarters, AMAPO = Powell amaranth, AMBEL = c. ragweed, ABUTH = velvetleaf, fb. = followed by., P = POST, LP = Late POST.
[1]Control of AMAPO and SINAR was 100% with all herbicide programs.

[2]Many 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
[3]Herbicide costs = avg. of price lists; App. cost = $10.00/A; seeding rate = 150,000 seeds/A. Weed control costs = Herbicide $ + Additive $ + Application $.
[4]Crop selling price = $14.80/bu + non-GMO premium $1.75/bu (December 2022). 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.
Injury ratings in bold are significant.

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5

General Observations and Interpretation:
Each year precipitation can impact outcomes of the various herbicide programs examined in the non-GMO soybean study. However, overall results between years remain fairly consistent. This year soybeans were planted, and PRE herbicides were applied on May 17. Precipitation within 7 and 14 d totaled 0.67- and 1.21-inches, respectively, resulting in good incorporation of the PRE herbicides. In general, soybean injury was fairly low from the PRE herbicide applications with only two treatments resulting in more than 10%, 35 DAP. These treatments contained the active ingredient flumioxazin (Valor). However, overall injury was 15% or less. Weeds that escaped control from the PRE treatments were predominately common ragweed, and some annual grasses, and on occasion common lambsquarters and velvetleaf. Out of the 22 PRE herbicide treatments, six treatments provided excellent control at the time of the POST and LPOS, so no POST or LPOS application was made. These treatments were Fierce MTZ (16 fl oz), Tendovo (2.35 qt), Zidua PRO (6 fl oz), Zidua PRO (6 fl oz) + Metribuzin (6 oz), Up-Stage (21 fl oz) + Preview 2.1 (25 fl oz), and Up-Stage (21 fl oz) + Moccasin MTZ (42 fl oz). The POST herbicides following PRE treatments provided varying levels of soybean injury and weed control. Soybean injury from POST or and LPOS treatments ranged from 10-27%, 7 DAT. Harmony SG + Flexstar + Select Max and Cobra applied at 10 fl oz caused the greatest injury. By 28 DAT soybean recovered from any injury. By 28 days after the LPOS treatments, all treatments with the exception of two provided greater than 90% control of all weed species. There was a significant range in costs of the herbicide programs ($35.64-$83.42). The PRE programs that did not need a follow up POST application were the least expensive programs. Soybean yield from the different treatments ranged from 68-77.6 bu/A, of these 13 of the 22 herbicide programs evaluated ranked amongst the highest yielding. All of the highest yielding programs in addition to two of the less expensive programs were ranked amongst the highest economic return. This year with good rainfall for incorporation six of the PRE programs held throughout the season; five ranked amongst the highest yielding and all six ranked amongst the highest economic returns. However, this is not always the case. 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.

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6