MSU Weed Science

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Economics of Weed Control Programs for non-GMO Soybean, 2012

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A field trial sponsored by the Michigan Soybean Promotion Committee (MSPC) was conducted in 2012 at the MSU 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. Nineteen different soil-applied (PRE) herbicide programs were applied immediately after soybean planting. Throughout the growing season each treatment was evaluated for soybean injury and weed control. The soil-applied herbicide programs were scouted for weed escapes and postemergence (POST) herbicides were applied to one set of the treatments to control escaped weeds. Within two weeks of the PRE herbicide application there was less than 0.4-inch of precipitation. This lack of rainfall reduced incorporation of the soil-applied herbicides, resulting in overall poor weed control from many of the PRE herbicide treatments. POST herbicide programs were designed to demonstrate and answer grower questions on some of the different POST tank-mix options for control of the primary weed escapes. 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. Site characteristics and herbicide application timings are described in Table 1. Table 2 describes the herbicide programs evaluated. The maximum soybean yield was 50.2 bu/A and yield loss due to weeds was extremely high. The weedy (untreated) yield was 15.2 bu/A, resulting in a yield loss of 35 bu/A (70%). Table 3 contains the data for soybean injury, weed control, herbicide program costs, soybean yield, and economic returns.

Table1. Site description.

Crop	Soybean
Variety	ZFS 830 Low Lin
Soil Texture	Loam
Soil pH	6.7
Soil Organic Matter	3.6
Dominant Weeds	ANGR, CHEAL, AMAPO, AMBEL, ABUTH
Planting Date	May 17
Application Timings:	
PRE	May 17
POST	June 12
Follow-up POST	June 14
Evaluation Times	Soybean injury – 30 d after planting & 7, 14, & 28 d after POST Weed control prior to harvest (28 d after POST)

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

Table 2. non-GMO soybean herbicide programs evaluated in 2012.

	PRE TREATMENT	POST TREATMENT	FOLLOWUP POST[b]	Abbreviated Form
1	Valor (2.5 oz) + Prowl H_2O (2 pt)	Flexstar (1 pt) + Harmony (0.125 oz) + SelectMax (9 fl oz) + NIS (0.25%)		Valor + Prowl fb. Flex + Harm + Select + NIS
2	Valor (2.5 oz) + Zidua (2.5 oz)	Flexstar (1 pt) + Harmony (0.125 oz) + SelectMax (9 fl oz) + COC (1%)		Valor + Zidua fb. Flex + Harm + Select + COC
3	Valor XLT (4 oz) + Sencor (4 oz)	Cobra (8 fl oz) + Harmony (0.125 oz) + Assure II (7 fl oz) + NIS (0.25%)		Valor XLT + Sencor fb. Cobra + Harm + Assure + NIS
4	Valor XLT (4 oz) + Zidua (2.5 oz)	Cobra (8 fl oz) + Harmony (0.125 oz) + Assure II (7 fl oz) + COC (1%)		Valor XLT + Zidua fb. Cobra + Harm + Assure + COC
5	Envive (3.5 oz) + Prowl H_2O (2 pt)	Select Max (9 fl oz) + COC (1%)	Flexstar (1 pt) + Harmony (0.125 oz) + NIS (0.25%)	Envive + Prowl fb. Select fb. Flex + Harm + NIS
6	Canopy (2.25 oz) + Valor (2 oz) + Sencor (2 oz) + Prowl H_2O (2 pt)	Select Max (9 fl oz) + COC (1%)	Flexstar (1 pt) + Harmony (0.125 oz) + COC (1%)	Canopy + Valor + Sencor + Prowl fb. Select fb. Flex + Harm + COC
7	Boundary (2.4 pt)	Basagran (1 qt) + Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Boundary fb. Bas + Flex + Select + COC
8	Python (0.8 oz) + Boundary (2 pt)	SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)	Basagran (1 qt) + Flexstar (1 pt) + COC (1%) + AMS	Python + Boundary fb. Select fb. Bas + Flex + COC
9	Authority XL (3.2 oz) + Boundary (2 pt)	Harmony (0.125 oz) + SelectMax (9 fl oz) + NIS (0.25%)	Flexstar (1 pt) + COC (1%) + AMS (2.5 lb)	Auth XL + Boundary fb. Harm + Select fb. Flex
10	Sencor (5 oz) + Dual II Magnum (1.33 pt) + Linex (1 pt)	Raptor (5 fl oz) + COC (1%) + AMS (2.5 lb)	Flexstar (1 pt) + COC (1%) + AMS (2.5 lb)	Sencor + Dual + Linex fb. Raptor fb. Flex
11	Canopy (4 oz) + Prefix (2 pt)	Harmony (0.125 oz) + SelectMax (9 fl oz) + NIS (0.25%)	Cobra (8 fl oz) + COC (1%)	Canopy + Prefix fb. Harm + Select fb. Cobra
12	Optill PRO (2 oz + 10 fl oz) + Outlook (8 fl oz) + Sencor (5 oz)	Cobra (8 fl oz) + COC (1%)	Harmony (0.125 oz) + SelectMax (9 fl oz) + NIS (0.25%)	Optill PRO + Outlook + Sencor fb. Cobra fb. Harm + Select
13	Authority MTZ (13 oz) + Dual II Magnum (1 pt)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Auth MTZ + Dual fb. Flex + Select
14	Authority MTZ (13 oz) + Command (21 fl oz)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Auth MTZ + Command fb. Flex + Select
15	Authority MTZ (16 oz)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Auth MTZ fb. Flex + Select
16	Authority XL (3.2 oz)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Auth XL fb. Flex + Select
17	Authority XL (3.2 oz)	Cadet (0.6 fl oz) + Flexstar (12 oz) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Auth XL fb. Cadet + Flex + Select
18	Authority First (6.4 oz)	Cadet (0.6 fl oz) + Flexstar (12 oz) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Auth 1st fb. Cadet + Flex + Select
19	Valor (3 oz)	Flexstar (1 pt) + SelectMax (9 fl oz) + COC (1%) + AMS (2.5 lb)		Valor fb. Flex + Select

[a] 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.

[b] The follow-up POST treatments were applied 2 d after the POST treatments.

Table 3. Soybean injury, weed control, program costs, soybean yield, and economic returns for non-GMO herbicide programs, 2012.

Herbicide Programs	Soybean Injury (POST)		ANGR	CHEAL	AMAPO	AMBEL[1]	ABUTH	All Weeds	Costs[2]	Yield	Economic Returns[3]
	7 DAT	28 DAT	Prior to harvest (28 d after POST)								
	(%)	(%)	% control					(≥90%)	($/A)	(bu/A)	($/A)
Valor + Prowl fb. Flex + Harm + Select + NIS	29	2	86	89	**99**	**90**	**96**	NO	$64.50	42.3	$527.70
Valor + Zidua fb. Flex + Harm + Select + COC	34	5	**95**	82	**99**	**91**	**99**	NO	$71.75	41.1	$503.65
Valor XLT + Sencor fb. Cobra + Harm + Assure + NIS	30	1	76	77	**99**	**92**	**99**	NO	$53.80	34.6	$430.60
Valor XLT + Zidua fb. Cobra + Harm + Assure + COC	33	4	84	**93**	**99**	**90**	**99**	NO	$68.50	**44.7***	**$557.30***
Envive + Prowl fb. Select fb. Flex + Harm + NIS	21	0	**95**	87	**99**	77	**93**	NO	$76.20	42.1	$513.20
Canopy + Valor + Sencor + Prowl fb. Select fb. Flex + Harm + COC	23	0	**97**	84	**99**	84	**97**	NO	$77.90	**45.3***	**$556.30***
Boundary fb. Bas + Flex + Select + COC	35	1	76	84	**92**	**99**	**99**	NO	$85.90	43.1	$517.50
Python + Boundary fb. Select fb. Bas + Flex + COC	25	0	**97**	83	80	**97**	**99**	NO	$101.60	**48.7***	**$580.20***
Auth XL + Boundary fb. Harm + Select fb. Flex	24	0	**92**	81	**99**	**94**	**96**	NO	$78.70	**47.9***	**$591.90***
Sencor + Dual + Linex fb. Raptor fb. Flex	23	2	**95**	85	**99**	**95**	**99**	NO	$92.10	**49.1***	**$595.30***
Canopy + Prefix fb. Harm + Select fb. Cobra	26	2	75	76	**99**	86	89	NO	$69.90	38.9	$474.70
Optill PRO + Outlook + Sencor fb. Cobra fb. Harm + Select	43	1	**90**	84	**99**	**96**	**98**	NO	$85.00	**50.1***	**$616.40***
Auth MTZ + Dual fb. Flex + Select	21	0	**95**	**92**	89	**98**	**99**	NO	$69.90	**50.2****	**$632.90****
Auth MTZ + Command fb. Flex + Select	24	0	**96**	**93**	87	**99**	**99**	NO	$78.40	**49.1***	**$609.00***
Auth MTZ fb. Flex + Select	23	1	**96**	**94**	**94**	**99**	**99**	**YES**	$58.90	**49.2***	**$629.90***
Auth XL fb. Flex + Select	19	0	**92**	76	83	**97**	**99**	NO	$50.20	40.7	$519.60
Auth XL fb. Cadet + Flex + Select	20	0	**95**	69	**91**	**96**	**99**	NO	$52.60	40.5	$514.40
Auth 1st fb. Cadet + Flex + Select	19	0	**93**	88	**94**	**97**	**99**	NO	$71.70	**50.1***	**$629.70***
Valor fb. Flex + Select	21	0	**97**	65	**97**	**98**	**99**	NO	$56.20	40.9	$516.40
Untreated	0	0	0	0	0	0	0	NO	—	15.2	$212.80

Abbreviations: ANGR = giant & yellow foxtail, CHEAL = c. lambsquarters, AMBEL = c. ragweed, ABUTH = velvetleaf, fb. = followed by.

[1] A portion of the common ragweed population may have been resistant to ALS-herbicides.

[2] Herbicide costs = avg. of price lists; App. cost = $7.50/A; seeding rate = 150,000 seeds/A. Weed control costs = Herbicide $ + Additive $ + Application $.

[3] Crop selling price = $14.00/bu (December 2012). Economic return = (Yield x Price) – Weed Control Costs.

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

General Observations and Interpretation:

The weed populations at the MSU Agronomy Farm were heavy infestations of annual grasses (mainly giant and yellow foxtail), common lambsquarters, Powell amaranth, common ragweed, and velvetleaf. Weather had a major impact on the overall outcome of the various herbicide programs. Early in the growing season there was very little rain (<0.4-inches) within two weeks of the soil-applied (PRE) herbicide applications. This lack of rainfall reduced incorporation of the soil-applied herbicides, resulting in overall unacceptable weed control from all PRE herbicide programs. All PRE herbicide programs were consistently poor for annual grasses (55 – 72%) and common ragweed (60 – 71%) control. There was a greater range of responses in common lambsquarters and Powell amaranth control from the different PRE treatments. Treatments that provided >90% common lambsquarters control contained Authority MTZ. Treatments that contained flumioxazin (Valor or Valor premixes) provided the greatest control of Powell amaranth.

Approximately 25 days after planting, POST herbicides programs were applied to each of the PRE herbicide programs. POST herbicide programs were designed to demonstrate and answer grower questions on some of the different POST tank-mix options for control of the primary weed escapes. Several different POST herbicide options were examined. Soybean injury was high for many of the POST herbicide tank-mixes, 7 DAT (Table 3). Over time soybean injury lessened, however some of the treatments causing the greatest injury were treatments that contained Cobra + crop oil concentrate (COC), either tank-mixed or applied sequentially within 2 days of Harmony SG.

Adjuvant selection and applying herbicides in combination or separated by a couple of days made a significant difference on how each program worked (Table 3). Annual grass control was greater than 90% when SelectMax was applied with COC in combination with other herbicides or by itself. There was one exception if SelectMax was applied with Flexstar + Basagran, antagonism occurred. The addition of Harmony SG provided fair to good control (>80%) of common lambsquarters. The PRE programs that had the best control of common lambsquarters helped with control. Control of Powell amaranth and velvetleaf was excellent for most treatments. Exceptions included the tank-mixture of Basagran + Flexstar (80%) for Powell amaranth and also control with Flexstar was not always consistent on Powell amaranth. Consistency of common ragweed control depended on initial control from the PRE program and herbicide timing. All treatments provided greater than 80% control, except Flexstar + Harmony + NIS. There was only one program that provided greater than 90% control for all weeds.

If weeds were not controlled soybean yield was 15.2 bu/A, which was a 70% reduction in yield from the highest yielding treatment (Table 3). Out of the 19 herbicide programs, 10 were amongst the highest yielding, with soybean yields ranging from 44.7 to 50.2 bu/A. Of the highest yielding herbicide programs, costs including application costs ranged from $58.90 to $101.60. Even with the wide range in herbicide program costs, all 10 herbicide programs that were amongst the highest yielding were amongst the programs with the highest economic returns, ranging from $556.30 to $632.90. The biggest factor contributing to herbicide programs with the greatest yield and economic returns was good to excellent control of all the weeds. There was only one exception where the treatment controlled all weeds >80% and did not rank amongst the highest yielding, but this treatment was at the cutoff for highest yields. Even treatments that included three herbicide applications with greater program costs were amongst the highest economic returns if the weeds were controlled. 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.