

Economics of Commercial Weed Control Programs in Soybean 2-Year Summary (2004 & 2005)

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Field trials in soybean were conducted in 2004 and 2005 at the MSU Research Farm in E. Lansing to compare weed control, soybean injury, soybean yield, and economic returns of dominant weed control programs being marketed to Michigan growers. Each major herbicide company was asked to submit up to four weed control programs for the studies based on soil type and weed infestation history. Site characteristics and herbicide application timings are described in Table 1. Table 2 describes the herbicides programs selected by each company for the 2004 season and Table 3 describes the herbicide programs that were selected by each company in 2005. Herbicide programs are sorted by application method and the need for Roundup Ready seed. Yield loss due to weeds was extremely high both years. In 2004, the maximum soybean yield was 67.7 bu/A and the weedy (untreated) yield was 21.3 bu/A, resulting in a yield loss of 46.4 bu/A (68.5%). In 2005, the maximum soybean yield was 62.7 bu/A and the weedy (untreated) yield was 20.8 bu/A, resulting in a yield loss of 41.9 bu/A (66%).

In 2004, immediately after planting and application of the preemergence herbicides the site received 0.53 inch of rainfall, which may have contributed to the persistent injury that was observed from some of the soil-applied herbicides.

Table 1. Site descriptions.

	2004	2005
Crop	Soybean	Soybean
Variety	Asgrow 2107	Asgrow 2107
Soil Texture	Sandy Loam	Sandy Clay Loam
Soil pH	7.6 ^a	6.3
Soil Organic Matter (OM)	3.8	1.8-2.2
Dominant Weeds	SETFA, CHEAL, AMARE, AMBEL, ABUTH, BRAKA, SOLPT	SETFA, CHEAL, AMARE, AMBEL, ABUTH, POLPY, BRAKA, SOLPT
Planting Date	May 29	May 4
Application Timings:		
PRE	May 29	May 4
Early POST (EPOS)	June 25	June 3
Mid-POST (MPOS)	July 1	June 8
POST	July 6	June 18
Late-POST (LPOS)	July 23	June 29
Evaluation Times	45 d (soybean injury) 65 d (weed control)	50 d (soybean injury) 75 d (weed control)

Abbreviations: SETFA = giant foxtail, CHEAL = common lambsquarters, AMARE = redroot pigweed, AMBEL = common ragweed, ABUTH = velvetleaf, POLPY = Pennsylvania smartweed, BRAKA = wild mustard, SOLPT = eastern black nightshade.

^a Due to the high soil pH in 2004 some of the programs listed in the 2004 trial would be restrictive to rotational crops the following season (i.e., programs containing chlorimuron). Additionally, there are restrictions for applications of metribuzin containing products when pH levels approach 7.5.

Table 2. Commercial soybean herbicide programs selected by companies in 2004.

<i>Conventional</i>	<i>Treatments (Rate/A)</i>	<i>Abbreviated Form</i>	<i>Years^a</i>
PRE	Outlook (18 fl oz) + Lorox (1.5 lb) + Sencor (4 oz)	Outlook + Lorox + Sencor	2004
	Axiom (13 oz) + Pursuit (1.44 oz)	Axiom + Pursuit	2004
	Python (0.8 oz) + FirstRate (0.3 oz) + Pendimax (3 pt)	Python + FRate + Pendimax	2004
	Boundary (2 pt) + Canopy XL (3.8 oz)	Boundary + Canopy XL	2004
	Gangster (3 oz) + Pendimax (2.4 pt)	Gangster(L) + Pendimax	2004, 2005
	Gangster (3.6 oz) + Pendimax (2.4 pt)	Gangster(H) + Pendimax	2004
PRE/POST	Prowl H ₂ O (2.5 pt) fb. Pursuit (1.44 oz) + Cobra (2 fl oz) + MSO (1%) + AMS (2.5 lb)	Prowl fb. Pursuit + Cobra	2004
	Prowl H ₂ O (2.5 pt) fb. Raptor (4 fl oz) + Cobra (2 fl oz) + MSO (1%) + AMS (2.5 lb)	Prowl fb. Raptor + Cobra	2004
	Python (1 oz) fb. FirstRate (0.3 oz) + Select (6 fl oz) + COC (1%) + 28% N (2.5%)	Python fb. FRate + Select	2004
	Canopy XL (3.5 oz) fb. Flexstar (1.5 pt) + Assure II (8 fl oz) + COC (1%)	Canopy XL fb. Flex + Assure	2004
	Boundary (1.75 pt) fb. Flexstar (16 fl oz) + COC (1 qt/100 gal) + AMS (10 lb/100 gal)	Boundary fb. Flexstar	2004, 2005
	Gangster (3 oz) fb. Select (6 fl oz) + COC (1 qt)	Gangster fb. Select	2004
<i>Roundup Ready</i>			
PRE/POST	Prowl H ₂ O (2.5 pt) fb. Extreme (3 pt) + Activator 90 (0.25%) + AMS (2.5 lb)	Prowl fb. Extreme	2004
	Sencor (5.3 oz) fb. Roundup WeatherMax (22 fl oz) + AMS (17 lb/100 gal)	Sencor fb. RoundupWM	2004, 2005
	Domain (10 oz) fb. Roundup WeatherMax (22 fl oz) + AMS (17 lb/100 gal)	Domain fb. RoundupWM	2004
	Python (0.8 oz) fb. Glyphomax Plus (32 fl oz) + AMS (2 lb)	Python fb. GlyphoPlus	2004
	Canopy XL (3.5 oz) fb. Roundup WeatherMax (22 fl oz) + AMS (17 lb/100 gal)	Canopy XL fb. RoundupWM	2004
	IntRRo (1 qt) fb. Roundup WeatherMax (22 fl oz) + AMS (2%)	IntRRo(L) fb. RoundupWM	2004, 2005
	IntRRo (2 qt) fb. Roundup WeatherMax (22 fl oz) + AMS (2%)	IntRRo(H) fb. RoundupWM	2004
	Boundary (1.75 pt) fb. Touchdown Total (24 fl oz) + AMS (17 lb/100 gal)	Boundary fb. Touchdown	2004, 2005
Valor (2 oz) - PRE fb. Roundup WeatherMax (22 fl oz) + AMS (17 lb/100 gal)	Valor fb. RoundupWM	2004	
POST (1-pass)	Glyphomax Plus (32 fl oz) + FirstRate (0.3 oz) + AMS (2 lb) - MPOS	GlyphoPlus + FRate	2004
POST (2-pass)	Extreme (3 pt) + Activator 90 (0.25%) + AMS (2.5 lb) fb. Roundup WeatherMax (22 fl oz) + AMS (2.5 lb) - EPOS fb. LPOS	Extreme fb. RoundupWM	2004
	Roundup OriginalMax (22 fl oz) + AMS (2%) - MPOS fb. LPOS	RoundupOM fb. RoundupOM	2004
	Roundup WeatherMax (22 fl oz) + AMS (2%) - MPOS fb. LPOS	RoundupWM fb. RoundupWM	2004, 2005
	Touchdown Total (24 fl oz) + AMS (17 lb/100 gal) - MPOS fb. LPOS	Touchdown fb. Touchdown	2004, 2005

^a Herbicide programs that were common in 2004 and 2005.

Table 3. Commercial soybean herbicide programs selected by companies in 2005.

<i>Conventional</i>	<i>Treatments (Rate/A)</i>	<i>Abbreviated Form</i>
PRE	Define (14.4 fl oz) + Pursuit (1 oz) + Sencor (6.4 oz) Synchrony XP (1.25 oz) + Linex (1 pt) + Cinch (1 pt) Gangster (3 oz) + Pendimax (2 pt) FirstRate (0.6 oz) + Dual Magnum (1.33 pt) – WeedSOFT	Define + Pursuit + Sencor Synchrony + Linex + Cinch Gangster + Pendimax FRate + Dual Magnum
PRE/POST	Prowl H ₂ O (2.5 pt) fb. Raptor (4 fl oz) + Flexstar (12 fl oz) + MSO (1%) + AMS (2.5 lb) Linex (1.5 pt) fb. Assure II (8 fl oz) + COC (1%) Synchrony XP (1.5 oz) fb. Flexstar (1.5 pt) + Assure II (8 fl oz) + COC (1%) + AMS (2 lb) Boundary (1.75 pt) fb. Flexstar (16 fl oz) + COC (1%) Domain (10 oz) fb. Flexstar (1 pt) + Assure II (8 fl oz) + COC (0.8 qt) + AMS (17 lb/100 gal) - WeedSOFT	Prowl fb. Raptor + Flexstar Linex fb. Assure Synchrony fb. Flexstar + Assure Boundary fb. Flexstar Domain fb. Flex + Assure
<i>Roundup Ready</i>		
PRE/POST	Sencor (5.3 oz) fb. Roundup WeatherMax (22 fl oz) + AMS (17 lb/100 gal) IntRRo (1 qt) fb. Roundup WeatherMax (22 fl oz) + AMS (2%) Boundary (1.75 pt) fb. Touchdown Total (24 fl oz) + AMS (17 lb/100 gal) Domain (10 oz) fb. Glyphosate (32 fl oz) + AMS (17 lb/100 gal) - WeedSOFT	Sencor fb. RoundupWM IntRRo(L) fb. RoundupWM Boundary fb. Touchdown Domain fb. Glyphosate
POST (1-pass)	Glyphosate (32 fl oz) + AMS (17 lb/100 gal) – MPOS - WeedSOFT	Glyphosate
POST (2-pass)	Roundup WeatherMax (22 fl oz) + AMS (17 lb/100 gal) - MPOS fb. LPOS Touchdown Total (24 fl oz) + AMS (17 lb/100 gal) - EPOS fb. LPOS Sequence (2.5 pt) + AMS (MP) fb. Touchdown Total (24 fl oz) + AMS (17 lb/100 gal) (LP)	RoundupWM fb. RoundupWM Touchdown fb. Touchdown Sequence fb. Touchdown

Table 4. Soybean injury, weed control, program costs, soybean yield, and gross margins for 26 herbicide programs in 2004.

Herbicide Programs	Soybean Injury (%)	SETFA, CHEAL, AMARE, BRAKA, SOLPT (>90%)	AMBEL (%)	ABUTH (%)	All Weeds (>90%)	Costs ¹ (\$/A)	Yield (bu/A)	Gross Margins ² (\$/A)
PRE(Conventional)								
Outlook + Lorox + Sencor	0	+	74	87	NO	\$50.28	60.4	\$251.72
Axiom + Pursuit	0	+	78	99	NO	\$35.67	57.1	\$249.83
Python + FRate + Pendimax	4	+	79	99	NO	\$26.90	52.9	\$237.60
Boundary + Canopy XL	23†	+	98	99	YES	\$28.23	51.3	\$228.27
Gangster(L) + Pendimax	8†	+	99	99	YES	\$28.30	54.2	\$242.70
Gangster(H) + Pendimax	5	+	96	99	YES	\$31.68	59.7	\$266.82*
PRE fb. POST (Conventional)								
Prowl fb. Pursuit + Cobra	3	+	71	99	NO	\$41.46	53.4	\$225.54
Prowl fb. Raptor + Cobra	13†	+	73	99	NO	\$41.62	55.7	\$236.88
Python fb. FRate + Select	1	+	93	99	YES	\$38.32	66.0*	\$291.68*
Canopy XL fb. Flex + Assure	20†	+	99	99	YES	\$48.40	56.3	\$233.10
Boundary fb. Flexstar	3	+	99	99	YES	\$38.50	62.7*	\$275.00*
Gangster fb. Select	3	+	99	99	YES	\$39.20	62.8*	\$274.80*
PRE fb. POST (Roundup Ready)								
Prowl fb. Extreme	4	+	99	99	YES	\$42.49	60.9*	\$262.01*
Sencor fb. RoundupWM	0	+	98	96	YES	\$37.68	65.2*	\$288.32*
Domain fb. RoundupWM	0	+	98	97	YES	\$38.61	63.0*	\$276.39*
Python fb. GlyphoPlus	0	+	98	99	YES	\$37.29	63.9*	\$282.21*
Canopy XL fb. RoundupWM	9†	+	98	99	YES	\$37.31	57.6	\$250.69
IntRRo(L) fb. RoundupWM	0	+	97	97	YES	\$35.72	63.5*	\$281.78*
IntRRo(H) fb. RoundupWM	0	+	99	97	YES	\$40.22	60.1	\$260.28*
Boundary fb. Touchdown	0	+	99	96	YES	\$45.00	67.7*	\$293.50*
Valor fb. RoundupWM	0	+	99	99	YES	\$39.13	65.2*	\$286.87*
POST 1-pass (Roundup Ready)								
GlyphoPlus + FRate	0	+	99	99	YES	\$31.68	63.1*	\$283.82*
POST 2-pass (Roundup Ready)								
Extreme fb. RoundupWM	0	+	97	99	YES	\$43.49	62.4*	\$268.51*
RoundupOM fb. RoundupOM	0	+	98	99	YES	\$37.57	60.0	\$262.43*
RoundupWM fb. RoundupWM	0	+	99	99	YES	\$41.21	67.4*	\$295.79*
Touchdown fb. Touchdown	0	+	99	99	YES	\$41.41	62.2*	\$269.59*
Untreated	0	0	0	0	NO	0	21.3	\$106.25

Abbreviations: SETFA = giant foxtail, CHEAL = common lambsquarters, AMARE = redroot pigweed, BRAKA = wild mustard, SOLPT = eastern black nightshade, AMBEL = common ragweed, ABUTH = velvetleaf, fb. = followed by.

¹ Herbicide and additive costs = avg. of price lists (April 2004); Application cost = \$6.00/A; Roundup Ready seed premium = \$9.25/A; seeding rate = 155,000 seeds/A. Weed control costs = Herbicide \$ + Additive \$ + Application \$ + seed premium \$ (where applicable).

² Crop selling price = \$5.00/bu (December 2004). Gross margin = (Yield x Price) – Weed Control Costs.

+ All treatments provided ≥90% control of weeds listed.

* Values are not significantly different from the highest value within that column.

† Indicates significant soybean injury 45 days after soybean planting.

Table 5. Soybean injury, weed control, program costs, soybean yield, and gross margins for 17 herbicide programs in 2005.

Herbicide Programs	Soybean Injury (%)	SETFA (%)	CHEAL (%)	AMARE (%)	AMBEL (%)	ABUTH (%)	POLPY (%)	BRAKA, SOLPT (>90%)	All Weeds (>90%)	Costs ¹ (\$/A)	Yield (bu/A)	Gross Margins ² (\$/A)
PRE(Conventional)												
Define + Pursuit + Sencor	0	99	99	99	97	99	99	+	YES	\$38.72	59.1*	\$256.78*
Synchrony + Linex + Cinch	0	99	99	99	72	91	99	+	NO	\$32.11	51.2	\$223.90
Gangster + Pendimax	0	82	99	94	99	94	99	+	NO	\$26.98	62.7*	\$286.36*
FRate + Dual Magnum	0	79	67	99	81	99	99	+	NO	\$32.99	56.2*	\$247.89*
PRE fb. POST (Conventional)												
Prowl fb. Raptor + Flexstar	17†	99	99	99	99	99	99	+	YES	\$48.31	52.6	\$214.82
Linex fb. Assure	5†	99	73	91	49	78	76	+	NO	\$30.83	44.8	\$193.30
Synchrony fb. Flexstar + Assure	19†	84	94	99	99	99	99	+	NO	\$48.02	54.4	\$223.98
Boundary fb. Flexstar	16†	99	97	99	99	98	99	+	YES	\$37.88	60.9*	\$266.45*
Domain fb. Flex + Assure	5†	99	99	99	99	96	99	+	YES	\$41.42	56.6*	\$241.58
PRE fb. POST (Roundup Ready)												
Sencor fb. RoundupWM	0	99	99	99	99	99	99	+	YES	\$44.19	58.6*	\$248.94*
IntRRo(L) fb. RoundupWM	0	99	99	99	96	99	99	+	YES	\$41.97	57.6*	\$246.03*
Boundary fb. Touchdown	1	99	99	99	99	99	99	+	YES	\$46.84	60.7*	\$256.49*
Domain fb. Glyphosate	0	98	99	99	98	99	99	+	YES	\$40.02	58.0*	\$250.37*
POST 1-pass (Roundup Ready)												
Glyphosate	0	83	96	86	95	98	99	+	NO	\$26.56	58.3*	\$265.07*
POST 2-pass (Roundup Ready)												
RoundupWM fb. RoundupWM	6†	98	99	99	99	99	99	+	YES	\$47.46	56.0*	\$232.29
Touchdown fb. Touchdown	0	98	99	99	99	99	99	+	YES	\$40.79	58.5*	\$251.59*
Sequence fb. Touchdown	4†	99	99	99	99	99	99	+	YES	\$49.17	58.2*	\$241.71
Untreated	0	0	0	0	0	0	0	0	NO	0	20.8	\$103.88

Abbreviations: SETFA = giant foxtail, CHEAL = common lambsquarters, AMARE = redroot pigweed, AMBEL = common ragweed, ABUTH = velvetleaf, POLPY = Pennsylvania smartweed, BRAKA = wild mustard, SOLPT = eastern black nightshade, fb. = followed by.

¹ Herbicide and additive costs = avg. of price lists (April 2005); Application cost = \$6.00/A; Roundup Ready seed premium = \$15.23/A; seeding rate = 155,000 seeds/A. Weed control costs = Herbicide \$ + Additive \$ + Application \$ + seed premium \$ (where applicable).

² Crop selling price = \$5.00/bu (December 2005). Gross margin = (Yield x Price) – Weed Control Costs.

+ All treatments provided ≥90% control of weeds listed.

* Values are not significantly different from the highest value within that column.

† Indicates significant soybean injury 50 days after soybean planting.

Table 6. Summary of instances of soybean injury, weed control, herbicide program costs, highest yielding, and highest gross margins for the five weed control systems in 2004.

	Soybean Injury	All Weeds Controlled ($\geq 90\%$)	5 Most Expensive	5 Least Expensive	Highest Yielding	Highest Gross Margins
<i>Conventional</i>						
PRE	2/6	3/6	1/6	4/6	0/6	1/6
PRE/POST	2/6	2/6	1/6	0/6	3/6	3/6
<i>Roundup Ready</i>						
PRE/POST	1/9	9/9	2/9	0/9	7/9	8/9
POST (1-pass)	0/1	1/1	0/1	1/1	1/1	1/1
POST (2-pass)	0/4	4/4	1/4	0/4	3/4	4/4

Information in Table 6 is based on results presented in Table 4.

Table 7. Summary of instances of soybean injury, weed control, herbicide program costs, highest yielding, and highest gross margins for the five weed control systems in 2005.

	Soybean Injury	All Weeds Controlled ($\geq 90\%$)	5 Most Expensive	5 Least Expensive	Highest Yielding	Highest Gross Margins
<i>Conventional</i>						
PRE	0/4	1/4	0/4	3/4	3/4	3/4
PRE/POST	5/5	3/5	2/5	1/5	2/5	1/5
<i>Roundup Ready</i>						
PRE/POST	0/4	4/4	1/4	0/4	4/4	4/4
POST (1-pass)	0/1	0/1	0/1	1/1	1/1	1/1
POST (2-pass)	2/3	3/3	2/3	0/3	3/3	1/3

Information in Table 7 is based on results presented in Table 5.

Table 8. A 2-year summary of all weed control programs for soybean yield (% of maximum yield) and gross margin (% of maximum gross margin).

	2004	2005	2004	2005
	— % of max. yield ^a —		— % of max. gross margin —	
PRE(Conventional)				
Outlook + Lorox + Sencor	89	—	85	—
Axiom + Pursuit	84	—	84	—
Python + FRate + Pendimax	78	—	80	—
Boundary + Canopy XL	76	—	77	—
Gangster(L) + Pendimax	80	100*	82	100*
Gangster(H) + Pendimax	88	—	90*	—
Define + Pursuit + Sencor	—	94*	—	90*
Synchrony + Linex + Cinch	—	82	—	78
FRate + Dual Magnum	—	90*	—	87*
PRE fb. POST (Conventional)				
Prowl fb. Pursuit + Cobra	79	—	76	—
Prowl fb. Raptor + Cobra	82	—	80	—
Prowl fb. Raptor + Flexstar	—	84	—	75
Python fb. FRate + Select	98*	—	99*	—
Canopy XL fb. Flex + Assure	83	—	79	—
Boundary fb. Flexstar	93*	97*	93*	93*
Gangster fb. Select	93*	—	93*	—
Linex fb. Assure	—	72	—	68
Synchrony fb. Flexstar + Assure	—	87	—	78
Domain fb. Flex + Assure	—	90*	—	84
PRE fb. POST (Roundup Ready)				
Prowl fb. Extreme	90*	—	89*	—
Sencor fb. RoundupWM	96*	94*	97*	87*
Domain fb. RoundupWM	93*	—	93*	—
Domain fb. Glyphosate	—	93*	—	87*
Python fb. GlyphoPlus	94*	—	95*	—
Canopy XL fb. RoundupWM	85	—	85	—
IntRRo(L) fb. RoundupWM	94*	92*	95*	86*
IntRRo(H) fb. RoundupWM	89	—	88*	—
Boundary fb. Touchdown	100*	97*	99*	90*
Valor fb. RoundupWM	96*	—	97*	—
POST 1-pass (Roundup Ready)				
GlyphoPlus + FRate	93*	—	96*	—
Glyphosate	—	93*	—	93*
POST 2-pass (Roundup Ready)				
Extreme fb. RoundupWM	92*	—	91*	—
RoundupOM fb. RoundupOM	89	—	89*	—
RoundupWM fb. RoundupWM	100*	89*	100*	81
Touchdown fb. Touchdown	92*	93*	91*	88*
Sequence fb. Touchdown	—	93*	—	84

* Values are not significantly different from the highest value within that column.

2004 Observations:

The immediate rainfall after application of the preemergence herbicides led to persistent injury from some of the soil-applied herbicides. Herbicide programs that did not provide greater than 90% control of all weeds, in particular common ragweed, did not rank among the highest yielding herbicide programs. The programs that did not control common ragweed or programs that had significant injury that persisted throughout the season did not rank among the highest yielding or the highest gross margins. Not all programs that were among the highest gross margins were among the highest yielding programs. Four out of five of the most expensive programs included programs that involved two applications and all five programs that were among the least expensive involved only one application. However, all but two programs with the highest gross margins were sequential herbicide programs (2-pass). Several programs, conventional and Roundup Ready provided excellent weed control, high soybean yields, and high gross margins.

2005 Observations:

This year there were two types of soybean injury observed. All conventional herbicide programs that contained POST herbicide applications caused some leaf “burn”, typical symptoms of the POST herbicides applied. In the Roundup Ready systems, soybeans were stunted by early season weed competition when the initial herbicide application was applied at the mid-POST timing (6-inch weeds). Even with soybean injury, 2 out of the 5 conventional sequential programs and all of the Roundup Ready programs ranked among the highest yielding. Not all of the herbicide programs that controlled weeds greater than 90% were among the highest yielding, and not all of the highest yielding programs provided greater than 90% weed control. Reduced weed control and soybean injury were factors that affected yield of the herbicide programs that weren’t ranked among the highest yielding. Not all of the highest yielding programs were ranked among the programs with the highest gross margins. Herbicide program cost contributed to the difference. Several programs, conventional and Roundup Ready provided excellent weed control, high soybean yields, and high gross margins.

Interpretation

Over the two years, weather had a major impact on the overall outcome of the various herbicide programs. In 2004, immediate rainfall after application of the preemergence herbicides caused some significant persistent soybean injury that reduced soybean yield and ultimately affected gross margins. This was not the case in 2005. Some of the highest yielding programs were total-PRE programs. Effective weed control, particularly of common ragweed was also important for preserving soybean yield. Consistently over the two years sequential herbicide programs (PRE followed by POST) in conventional soybeans tended to provide the greatest weed control, soybean yield, and gross margin. In Roundup Ready soybeans several programs provided excellent weed control, high soybean yields, and high gross margins. Across all herbicide programs over the two years sequential programs that included a residual herbicide preemergence tended to rank among the highest yielding and gross margins.