Use of Residual Herbicides for Tough to Control Weeds in Snap Beans

Final Report for 2012

Submitted to

Pennsylvania Vegetable Marketing and Research Program
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Introduction:

Snap beans are produced on approximately 7,000 acres in Pennsylvania and 3,000 acres in Delaware (PDA Ag Statistics, 2009-10; DE Agricultural Statistics). Weed control can be a problem in this very important processing and fresh market crop. Weed control impacts snap bean yield as well as harvest efficiency, harboring other pests, and reducing the deposition of other pesticides. Only a limited number of herbicides are currently available for snap beans. Balancing herbicide selection to provide residual weed control throughout the growing season, but not limiting rotations can be challenging. Some herbicides such as the Raptor, Pursuit, Sandea, and Reflex have replant restrictions that can impact their use. Furthermore, there have been documented herbicide-resistant weed biotypes to some of these herbicides in our region. Other herbicides such as Basagran have little to no impact on crop rotations but Basagran has a very limited number of weed species that it controls. Furthermore, certain weeds such as common lambsquarters and common ragweed can sometime be difficult to control especially if they escape soil-applied herbicides or in dry weather situations.

Research in the Mid-Atlantic region has demonstrated that when certain herbicides are used in certain combinations they tend to complement each other quite well (i.e. Reflex plus Basagran). A number of issues for herbicide usage in the Mid-Atlantic region need additional work to determine the consistency of results, and obtain data over a wider range of environmental and production conditions.

We proposed to continue the evaluation of weed control programs in snap beans, building upon previous trials. This project has two main emphasizes, to determine the most efficient use of residual herbicides (use at planting [PRE] versus postemergence [POST]), and evaluating herbicide combinations and surfactants for difficult to control weeds in snap beans, particularly lambsquarters. Reflex and Sandea are labeled for both PRE and POST application and we evaluated which approach provided the most benefit for this region. In addition, we evaluated two residual herbicides for their potential use in snap beans (Sharpen and Zidua). Secondly, we evaluated Basagran, Reflex, Sandea, and Raptor applied postemergence (POST) at different use rates and in tank-mix combinations. The inclusion of certain adjuvants (e.g., surfactants) was also evaluated to determine if any provide improved postemergence herbicide performance with minimal crop injury. The studies were conducted at the Penn State research farm in Centre County and at the University of Delaware, Georgetown research farm. The purpose of conducting research at multiple locations over more than one growing season, is to evaluate these herbicide programs under different growing and climatic conditions, including different soil types, broader range of weed species, and irrigated and non-irrigated conditions. Benefits to Pennsylvania snap bean growers include updated information in vegetable production guides and other educational resources on how to more efficiently control weeds, especially troublesome broadleaf weeds, with greater rotational flexibility, improved resistance management, and with existing products.

Objectives:

1. Determine the most efficient use of residual herbicides (use at planting [PRE] versus postemergence [POST]);
2. Evaluate herbicide combinations and surfactants for difficult to control weeds in snap beans, particularly lambsquarters.
3. Determine the effect of these herbicide treatments on snap bean stand, injury, and yield.

Methodology:

Experiments were conducted at two locations: the Russell E. Larson Agricultural Research Farm in Centre County and at the University of Delaware Research and Extension Center in Sussex County in 2012. The

original protocol was modified and split into evaluation of preemergence (PRE) herbicides and a second trial evaluating postemergence (POST) herbicides. The core treatments were the same at both locations, but additional treatments were included to adjust for local practices. The preemergence study evaluated preemergence control of annual weeds in a stand of snap beans (Tables 1 and 3). The studies were planted and sprayed on June 29 at PSU and July 5 at UD. Preemergence treatments were applied immediately after planting. The postemergence study at PSU was conducted in a fallow setting with a dense population of several weed species (Table 2). The postemergence trial at UD was treated with Dual Magnum at 1.25 pts at planting and POST treatments were applied July 19, when weeds averaged 4 inches tall and the snap beans were 1st to 2nd trifoliate stage. The treatments were evaluated in a randomized complete block design with three replications. The plots were 10 feet wide by 25 feet long, and 'Slenderpack' was planted at PSU and 'Dart' was planted at UD. Plots were not cultivated. Crop injury and/or weed control was evaluated routinely, and yield was collected on September 4 at PSU and August 23 at UD

Results & Discussion – Rock Springs: (Tables 1 & 2):

- Site is a silt loam soil pH 6.7 , and 2.2 % organic matter
- In the preemergence study, all treatments provided 82-94% control of giant foxtail.
- All treatments, except for Dual + Sandea or Reflex, provided 90% or greater control of lambsquarters. Aside from Dual + Sandea, all treatments provided 90% or greater control of redroot pigweed.
- Treatments that contained Zidua initially caused 5-6% injury to snap beans but did not cause any yield reduction.
- Yields ranged from 5.6 to 8.8 tons/A. However, there was a trend toward better yields in all of the plots that had a herbicide treatment compared to the untreated check.
- In the postemergence study, none of the treatments provided >80% control of all the of weed species. Treatment of Basagran + Sandea + Raptor + NIS was the most consistent and provided 79 to 93% control of the weeds. Sandea + Raptor + NIS also provided adequate control (79 to 89%) of the species. The Basagran (3 pt) + Raptor + COC + UAN also provided more consistent control of the species, however the higher rate of Basagran and the addition of the "hotter" adjuvants would likely cause too much injury/burning to snap bean. (This is a program that is labeled for use in soybeans.)
- For best results apply herbicide to weeds they are small (i.e. < 6-8 inches tall). However, when controlling larger weeds be sure to include the appropriate herbicide for the weeds present. In this trial, lambsquarters control was best with Raptor; common ragweed control was best with Sandea or Reflex; pigweed control was best with include Sandea or Raptor; and Basagran provided the smartweed control.
- Size of the weed at application time matters. For example, the lambsquarter population ranged from 2" to 20" tall. Because of this, control varied from 50 to 65% control of lambsquarters >15" tall and 80-90% lambsquarters control if they were 12" or less at application.
- Spray coverage also was an issue. In areas were the weeds were dense and tall, control was reduced.
- In general, there was no significant difference on weed control between the adjuvants that were included in the spray mixture.

Results & Discussion – UD REC: (Tables 3 & 4):

- Site was a loamy sand, pH 6.0, and 1.3% organic matter
- In the soil-applied study Sharpen reduced snap bean stands by 90%, not a viable option for snap beans on coarse-textured soils
- Zidua caused stunting that was visible until pod formation
- The site received irrigation immediately after preemergence application which increased injury in this trial, particularly with Sandea. In situations where irrigation or significant rainfall occurs within a day or two of application, stunting is often observed. Sandea was safer when applied as a postemergence herbicide in this trial.
- Yields were highest with Dual and Reflex applied at planting or Reflex applied postemergence and Dual followed by Sandea. Sandea as preemergence application resulted in lower yields than when it was applied postemergence. Zidua treatments had the lowest yields in the trial.
- Pigweed weed control was not different among the treatments, ranging from 86 to 100% control. There was little difference among treatments for morningglory control (Sharpen provided 82% control but injury was not acceptable). Sandea, either preemergence or postemergence provided the highest level of control, but was only 71 to 75% control.
- The higher rate of Dual Magnum (1.67 pts compared to 1.25 pts) did not differ from the lower rate, so there was no benefit to the additional 0.5 pt of Dual Magnum in this trial.
- In the postemergence study crop injury did not differ with surfactant selection with Raptor plus Basagran, but the addition of 30% UAN increased injury with Basagran plus Reflex. As in the preemergence study, Sandea applied postemergence was safer than preemergence applications.
- At 2 week after treatment, herbicides applied with LI-700 had less injury than either NIS alone or NIS plus UAN, but no differences were observed 4 weeks after treatment.
- All treatments provided excellent control of common lambsquarters and pigweed species.
- Morningglory control was best with Raptor plus Basagran plus NIS plus UAN and the three-way combination of Reflex, Basagran, plus Raptor.
- Yields were similar for all treatments in this trial. Hot weather forced a split set of snap beans that severely impacted yield.

Two-year Summary:

<u>Snap bean injury:</u>

- More snap bean injury was observed in DE than at PSU for both years. Although the addition of 30% UAN increased injury with Basagran plus Reflex at UD in 2012, this was not observed at the other sites or years.
- Adjuvants at both locations did not increase the amount of crop injury, nor did they a significant impact on weed control
- Some of the preemergence herbicides had more injury at UD as well. Sharpen resulted in unacceptable snap bean injury, and Zidua caused stunting that was visible until pod formation; and both reduced yields.
- In situations where irrigation or significant rainfall occurs within a day or two of application, stunting from Sandea is often observed. Sandea was safer when applied as a postemergence herbicide.

<u>Weed control:</u>

- Overall lack of consistency in weed control results from site to site and year to year.

- Pigweed weed control generally did not differ among the treatments, ranging from 84 to 100% control.
- Sandea and Reflex were much more effective for common lambsquarters control when applied as PRE application rather than POST All other treatments were over 93% control in DE, whereas only Dual plus Reflex as a PRE treatment was rated over 90% control at PSU.
- Morningglory was only present at the UD location, and in 2012, control was best with Raptor plus Basagran plus NIS plus UAN and the three-way combination of Reflex, Basagran, plus Raptor (over 80% control); and in addition Basagran plus Reflex performed well in 2011.

Table 1. Effect of PRE herbicides on weed control, crop injury, and yield in snap bean at Centre Co., PA, 2012. Late-season ratings are presented*. Snap bean variety is 'Slenderpack'.

Herbicide(s)	Rate/A	Giant foxtail control (%)	Lambsquarters control (%)	Pigweed control (%)	Slenderpack Injury (%)	Slenderpack Yield (Ton/A)
Untreated	-	0	0	0	0	5.6
Dual Magnum + Sandea	1.67 pt + 0.67 oz	82	82	84	1	7.0
Dual Magnum + Reflex	1.67 pt + 1.25 pt	89	85	91	1	7.9
Dual Magnum + Sharpen	1.67 pt + 1 fl oz	92	90	89	2	8.2
Zidua + Reflex	2 oz + 1.25 pt	90	91	95	3	8.9
Zidua + Sandea	2 oz + 0.67 oz	82	88	90	3	8.0
Dual Magnum + Lorox	1.67 pt + 1.3 lb	92	96	96	1	7.2
Dual Magnum + Reflex + Pursuit	1.67 pt + 1.25 pt + 1.5 fl oz	94	94	97	1	6.8
LSD (P=.05)		14	10	12	2	3.6

* Late season ratings taken 9/4/2012; snap beans harvested 9/4/2012

Table 2. Effect of POST snap bean herbicides on “large” broadleaf weed control at Centre Co., PA, 2012*.
No crop was planted

Herbicides* (adjuvant)	Rate/A	Lambs-quarters control (%)	Common ragweed control (%)	Redroot pigweed control (%)	Smartweed control (%)
Untreated	-	0	0	0	0
Reflex (NIS)	1 pt 0.25%v/v	39	77	79	76
Sandea (NIS)	0.67 oz 0.25%v/v	10	88	80	74
Sandea + Reflex (NIS)	0.67 + 1 pt 0.25%v/v	38	82	83	84
Sandea + Raptor (NIS)	0.67 + 4 fl oz 0.25%v/v	80	89	86	79
Basagran + Sandea + Raptor (NIS)	1.5 pt + 0.67 oz + 4 fl oz 0.25%v/v	79	88	88	93
Basagran + Raptor (NIS + UAN)	1.5 pt + 4 fl oz 0.25%v/v 2 qt/A	74	72	86	93
Basagran + Raptor (NIS)	1.5 pt + 4 fl oz 0.25%v/v	77	65	86	92
Basagran + Raptor (LI 700)	1.5 pt + 4 fl oz 4pt/100gal	71	62	84	94
Basagran + Reflex (NIS + UAN)	1.5 pt + 0.75 pt 0.25%v/v 2 qt/A	56	88	69	95
Basagran + Reflex (NIS)	1.5 pt + 0.75 pt 0.25%v/v	43	85	74	93
Basagran + Reflex (LI 700)	1.5 pt + 0.75 pt 4pt/100gal	55	90	80	93
Basagran + Raptor + Reflex (NIS)	1.5 pt + 4 fl oz + 0.75 pt 0.25%v/v	66	87	87	94
Basagran + Raptor (COC + UAN)	3 pt + 4 fl oz 1 qt/A 1 gal/A	81	79	86	96
LSD (P=.05)		16	13	9	6

* Late season ratings taken 7/19/2012

Table 3. Effect of PRE herbicides on crop injury, weed control, and yield at University of Delaware's Research and Education Center, Georgetown, DE*. Snap bean variety is 'Dart'.

Herbicide(s)	Rate/A	Applic. timing	Snap Bean Stunting % July 17	Snap Bean Stunting % July 31	Snap Bean Stunting % Aug 13	Pigweed Species Control % Aug 13	Morngl ry Species Control % Aug 13	Snap Bean Yield lbs / A Aug 23
Untreated	-		0	0	0	0	0	N/A
Dual + Sharpen	1.25 pt + 1 fl oz	PRE	96.3 a	90 a	91.7 a	86	81.7 a	N/A
Dual + Reflex	1.25 pt + 1.25 pt	PRE	7 d	5.7 d	3.3 cd	95	60 c	5065 ab
Zidua + Reflex	2 oz wt + 1.25 pt	PRE	23.3 b	28.3 b	15.7 b	100	69.3 bc	3373 c
Dual fb Reflex + NIS	1.25 pt fb 1 pt	PRE POST	9 d	15 c	9 bc	90	61.7 c	5111 ab
Dual + Sandea	1.25 pt + 0.67 oz wt	PRE	18.3 c	26.7 b	9 bc	96	71 abc	4173 bc
Dual fb Sandea + NIS	1.25 pt fb 0.67 oz wt	PRE POST	0 e	2.3 d	0 d	100	75 ab	6617 a
Dual + Reflex	1.67 pt + 1.25 pt	PRE	10.7 d	9.7 cd	0 d	100	63.3 c	5083 ab
LSD (P=.05)			4.16	7.34	7.42	10.5	11.53	1593
Treatment Prob (F)			0.0001	0.0001	0.0001	0.0748	0.0143	0.019

*Treatments in each column followed by the same letter are not significantly different.

Table 4. Effect of postemergence (POST) herbicides on crop injury, weed control, and yield at University of Delaware's Research and Education Center, Georgetown, DE*. Snap bean variety is 'Dart'. **

Herbicide(s) Adjuvant(s)	Rate / A	Applic. timing	Snap Bean Stunt % July 28		Snap Bean Stunt % Aug 1		Snap Bean Stunt % Aug 13	Morningglory Species Control % Aug 13		Snap Bean yield lbs / A Aug 23	
Untreated			0		0		0	0		4243	a
Basagran + Raptor NIS+ 30% UAN	1.5 pt + 4 fl oz 0.25% + 2 qt	POST POST	10.7	d	9.7	cde	5.7	87	a	4377	a
Basagran + Raptor NIS	1.5 pt + 4 fl oz 0.25%	POST POST	9	d	9.7	cde	3.3	75	bcd	5451	a
Basagran + Raptor LI-700	1.5 pt + 4 fl oz 0.25%	POST POST	13	cd	4.7	ef	4	78	abc	5804	a
Basagran + Reflex NIS+ 30% UAN	1.5 pt + 0.75 pt 0.25% + 2 qt	POST POST	18.3	ab	15	bc	2.3	72	cd	4494	a
Basagran + Reflex NIS	1.5 pt + 0.75 pt 0.25%	POST POST	11.3	d	10.7	bcd	2.3	75	bcd	5850	a
Basagran + Reflex LI-700	1.5 pt + 0.75 pt 0.25%	POST POST	13.3	bcd	0	f	2.3	68	d	5209	a
Basagran + Raptor +Reflex NIS	1.5 pt + 4 fl oz + 0.75 pt 0.25%	POST POST	11.3	d	9	de	3.3	82	ab	5037	a
Dual + Reflex Sandea + NIS	1.25 pt + 1.25 pt 0.67 + 0.25%	PRE POST	17.3	bc	15.7	ab	5.7	76	bcd	4912	a
Dual + Sandea Reflex + NIS	1.25 pt + 0.7 oz wt 1 pt + 0.25%	PRE POST	23.3	a	20.7	a	11.7	79	abc	4372	a
LSD (P=.05)			5.14		5.54		7.1	9		1831	
Treatment Prob(F)			0.0004		0.0001		0.2062	0.0216		0.5119	

*Treatments in each column followed by the same letter are not significantly different.
**Entire site was treated with Dual Magnum at 1.25 pt/A
#POST treatments made to 4" tall weeds (snap beans were 1st to 2nd trifoliate stage)

Pictures from the postemergence study at Rock Springs.

Photo taken a few days after application

Photo taken a couple weeks after application

End of season – Untreated check

End of season – Sandea + NIS treatment

End of season – Sandea + Raptor + NIS

End of season – Basagran + Sandea + Raptor + NIS

Addendum: 2011 Data. Snap bean trials for management of troublesome weed species at PSU's Russell E. Larson Agricultural Research Farm in Centre County and the University of Delaware Research and Extension Center in Sussex County in 2011. Dual Magnum rates in DE were 1.25 pts/A and 1.67 pts/A at PSU due to sandier soil type (loamy sand versus silt loam). PRE=preemergence applications made at planting; POT=postemergence applications at 3 to 4 weeks after planting; WAT=weeks after treatment. Treatments followed by the same letter are not significantly different from one another.

Activity	PSU	UD
Variety	'Slenderpack'	'Dart'
Planting date	June 3, 2011	June 15, 2011
PRE applications	June 3, 2011	June 15, 2011
POST applications	July 6, 2011	July 7, 2011
Yields	August 1, 2011	August 1. 2011

				PSU Centre County								UD Sussex County							
				Snap bean		Lambsqrtr		Velvetleaf		Snap bean		Snap bean		Lambsqrtr		Morningglory		Snap bean	
				21-Jul		1-Aug		1-Aug		1-Aug		22-Jul		1-Aug		1-Aug		1-Aug	
Treatment		Rate	Applic	% Injury		Control %		Control %		Yield (lb/A)		% Injury		Control %		Control %		Yield (lb/A)	
Name	Rate	(/A)	Timing	2 WAT		4 WAT		4 WAT				2 WAT		4 WAT		4 WAT			
Untreated				0	d	0	d	0	b	1442	ab	0	e	0	c	0	c	n/a	
Dual	**		PRE	1	cd	90	a	57	a	2255	ab	3.3	cde	100	a	44	b	487	a
+Reflex	1.67	Pt	PRE																
Dual	**	**	PRE	3	cd	60	bc	55	a	1977	ab	1.7	de	70	b	69	a	1020	a
fb Reflex	1	pt/a	POST																
+NIS	0.25	% v/v	POST																
Dual	**	**	PRE	3	bcd	85	ab	60	a	1884	ab	9.6	abc	100	a	67	ab	364	a
+Sandea	0.67	oz/a	PRE																
Dual	**	**	PRE	6	bcd	52	c	80	a	2092	ab	0	e	0	c	44	b	856	a
fb Sandea	0.67	oz/a	POST																
+NIS	0.25	% v/v	POST																
Dual	**	**	PRE	5	bcd	77	abc	81	a	3045	a	11.7	ab	100	a	76	a	821	a
+Reflex	1.25	pt/a	PRE																
fb Sandea	0.67	oz/a	POST																
+NIS	0.25	% v/v	POST																

Dual	**	**	PRE	7	bc	73	abc	84	a	2149	ab	14	a	100	a	83	a	487	a
+Reflex	1.25	pt/a	PRE																
fb Sandea	0.67	oz/a	POST																
+LI 700	0.5	% v/v	POST																
Dual	**	**	PRE	4	bcd	81	ab	65	a	2827	a	14	a	100	a	90	a	470	a
+Sandea	0.67	oz/a	PRE																
fb Reflex	1	pt/a	POST																
+NIS	0.25	% v/v	POST																
Dual	**	**	PRE	7	bc	73	abc	78	a	1561	ab	13.3	a	97	a	86	a	866	a
fb Basagran	1.5	pt/a	POST																
+Raptor	4	fl oz/a	POST																
+NIS+UAN	0.25	% v/v	POST																
Dual	**	**	PRE	5	bcd	72	abc	70	a	2565	ab	4.7	b-e	100	a	70	a	917	a
fb Basagran	1.5	pt/a	POST																
+Raptor	4	fl oz/a	POST																
+NIS	0.25	% v/v	POST																
Dual	**	**	PRE	6	bcd	72	abc	60	a	2284	ab	8	a-d	100	a	78	a	929	a
fb Basagran	1.5	pt/a	POST																
+Raptor	4	fl oz/a	POST																
+LI 700	0.5	% v/v	POST																
Dual	**	**	PRE	10	b	75	abc	70	a	1903	ab	13.3	a	97	a	85	a	710	a
fb Basagran	1.5	pt/a	POST																
+Reflex	0.75	pt/a	POST																
+NIS+UAN	0.25	% v/v	POST																
Dual	**	**	PRE	4	bcd	73	abc	70	a	3499	a	11.7	ab	100	a	84	a	657	a
fb Basagran	1.5	pt/a	POST																
+Reflex	0.75	pt/a	POST																
+NIS	0.25	% v/v	POST																
Dual	**	**	PRE	7	bc	77	abc	71	a	1993	ab	9	abc	93	a	74	a	720	a
fb Basagran	1.5	pt/a	POST																
+Reflex	0.75	pt/a	POST																
+LI 700	0.5	% v/v	POST																

**Dual formulation was Dual Magnum and rate at PSU was 1.67 and 1.25 for UD.