Report of Research to the

Agricultural Research Foundation

and the

Oregon Processed Vegetable Commission

TITLE: Weed Control in Snap Beans and Edamame with Reflex herbicide

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Summary

The objectives were to evaluate crop safety and weed control with Reflex (fomesafen) applied to snap beans and Reflex and Spartan to edamame. Reflex caused very little injury to snap beans at two sites when applied PRE and only minor injury when applied EPOST. Tank mixes with Dual Magnum were extremely effective on lambsquarters, even though lambsquarters was poorly controlled by Reflex applied alone. Injury was visible on edamame and emergence may have been reduced slightly in two of the three replications in plots treated with Spartan at 12 oz/A. No injury was noted with Reflex. Edamame yield was not impacted by either Spartan or Reflex.

Justification

This project evaluated new strategies for weed control in snap beans. While much of the work has been done controlling the major species of weeds in the system there are some vulnerabilities that need be addressed. A primary concern is the use of Raptor herbicide, probably applied to as much as 50% of the snap bean acreage each year. This is a concern because Raptor is an imidazolinone herbicide that if left to fate, will select for herbicide resistance very quickly. As far as we know, there are no reported cases of nightshade resistance in the WV. That is probably due to the very diverse rotations that we have here. There are no other herbicides with the same mode of action that overlap in selection pressure with Raptor herbicide. We have, however, noted weed shifts, particularly toward weeds of the sunflower family such as groundsel. This is because Raptor is very weak on the sunflower family and we are beginning to see burgeoning populations of these weeds in snap beans, particularly in the spring.

But nothing is static and here is an opportunity we should consider. Reflex was recently given a tolerance for several crops (including bell pepper and tomato) and also was labeled on at least one crop west of the Mississippi for the first time, namely potatoes in Idaho. Reflex was the herbicide of choice for snap beans by OSU researcher as dinoseb was being withdrawn from the market in 1989. The registrant was unable to label the product at that time, and Cobra was selected instead. You well know the shortcomings of Cobra; unpredictable crop safety, particularly in early spring and when showers are swift and fierce. Testing we did in 2005 indicated that Reflex could be used both PRE and EPOST with little risk to the beans.

Edamame is a new crop to the PNW and for that reason little is known about weed control. Spartan was recently labeled, but we have no crop safety data on the cold soils of OR springs on edamame in the WV and potential differences among varieties.

The objective of this research was to evaluate crop safety and weed control with PRE and EPOST Reflex and Spartan on early season snap beans and edamame. Snap bean experiments were

located at Corvallis (OSU Veg. Res. Farm) and Stayton, and an edamame trial was placed north of Keizer.

Exp I. Stayton

Methods. Sandea and Eptam were applied on June 12 to designated plots, then the entire plot was vibra-shanked and rolled twice to plant incorporate the herbicide and the fertilizer that was broadcast over the entire plot. Snap beans were planted on June 13 and then rolled in between showers. The soil was very moist when rolling and some of the soil was removed from the surface, exposing the seed, and producing very erratic emergence. herbicides were applied one day later. EPOST treatments were applied on July 12 to beans that were mostly at the 1st trifoliate stage, with 10-20% at the 2nd trifoliate state or even larger. Bean pods were harvested from 8.2 ft of the middle row in each plot on August 17 and graded.

Results. Lambsquarters control was poor in Reflex only treatments. Snap bean yield was primarily a function of weed control at the end of the season (Figure 1). Tank mixing Dual Magnum with Reflex improved overall weed control and yield substantially. Reflex flowed by (fb) Raptor and Basagran also provided good weed control and greater yields than Reflex alone. Eptam plus Sandea did not control nightshade as well as anticipated, but did provide reasonable control of lambsquarters.

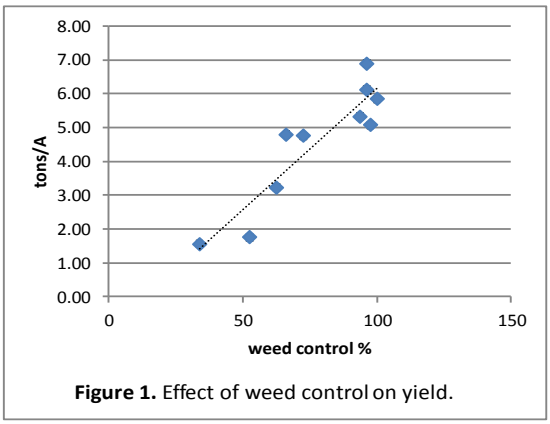

Figure 1. Effect of weed control on yield.

Table 1. Application data for Exp I.

Date	June 11, 2013	June 14, 2013	July 12, 2013
Crop stage	PPI		Highly variable. Most 1st tri, 10-20% 2nd tri or more
Herbicide/treatment	Eptam and Sandea		EPOST
Application timing	PPI		EPOST
Start/end time	4:00- 5 PM	6:30- 8 AM	7:30- 8 AM
Air temp/soil temp (2")/surface	66/76/76	51/54/53	60/63/63
Rel humidity	53%	63%	57
Wind direction/velocity	W 1-3	0	N 0-1
Cloud cover	100 showery	foggy	0
Soil moisture	Dry	Very wet	Dry
Plant moisture	-	-	Light dew
Sprayer/PSI	BP CO2 25 PSI	BP CO2 30 PSI	BP CO2 30 PSI
Mix size	2100	2100	2100
Gallons H20/acre	20	20	20
Nozzle type	5XR-8003	4XR-8003	4XR-8003
Nozzle spacing and height	20/24	20/24	20/24
Soil inc. method/implement	Vibrashank + roller 2x	Irrigation and rainfall	Irrigate on 7-13/14

Table 2. Weed control and yield in snap beans, Stayton, OR 2013.

	Herbicide	Timing	Rate		Weed control at harvest						Snap bean yield				
					Lambsquarters	Black nightshade	Hairy nightshade	Smartweed	Shepherdspurse	Composite rating	Plant stand	Plant Biomass	Pod yield	Avg. plant wt.	Grade
			product/A	*lbs ai/A*	---------- % ----------						*no/8.2 ft*	*lbs/8.2 ft*	*Tons/A*	*kg*	*% 1-4*
1	Reflex	PRE	1 pt	0.25	45	75	75	75	75	63	53	8.4	3.23	0.16	75
2	Reflex Dual Magnum	PRE PRE	1 pt 1 pt	0.25 0.9525	96	100	100	100	100	96	53	13.3	6.90	0.25	77
3	Reflex	EPOST	1 pt	0.25	48	93	93	95	50	53	35	4.4	1.75	0.14	71
4	Reflex Dual Magnum	EPOST PRE	1 pt 1 pt	0.25 0.9525	70	93	95	100	100	66	55	10.5	4.80	0.19	64
5	Reflex Raptor Basagran +NIS 0.25%	PRE EPOST EPOST	1 pt 4 oz 1 pt	0.25 0.03125 0.5	90	100	100	100	100	94	45	9.8	5.33	0.27	74
6	Reflex Dual Magnum Raptor Basagran +NIS 0.25%	PRE PRE EPOST EPOST	1 pt 1 pt 4 oz 1 pt	0.25 0.9525 0.03125 0.5	100	100	100	100	100	100	54	10.9	5.85	0.20	78
7	Outlook Raptor Basagran +NIS 0.25%	PRE EPOST EPOST	14 oz 4 oz 1 pt	0.656 0.03125 0.5	96	98	98	100	100	96	49	12.1	6.13	0.25	76
8	Dual Magnum Raptor Basagran +NIS 0.25%	PRE EPOST EPOST	1 pt 4oz 1 pt	0.9525 0.03125 0.5	96	100	100	100	100	98	50	9.7	5.08	0.22	79
9	Sandea Eptam	PPI PPI	1 oz 4.5 qt	0.047 3.94	89	75	68	100	75	73	56	10.6	4.75	0.19	71
10	Check	-	-	-	34	50	50	50	50	34	50	5.0	1.55	0.10	71
	FPLSD (0.05)				*29*	*40*	*ns*	*36*	*ns*	*32*	*ns*	*2.9*	*1.98*	*0.10*	-

Exp. II. Corvallis

Methods. The site was located at the Veg Research Farm just east of Corvallis on a Chehalis silty clay loam soil with a pH 6.01, OM 3.91% (LOI) %, and CEC of 24.5 meq/100 g soil. Snap beans were seeded into plots on June 13 at 10 seeds/foot or 174,000 seeds/A. Plots were 11 ft by 20 ft and with 4 rows on a 2.5 ft spacing, with 4 replications of each treatment. Three rows were planted to Var. 5402, and one row to Savannah. Fertilizer (353 lbs 12-29-10) was banded next to the row at planting. treatments were applied June 14, 2013, and irrigation applied June 16 to incorporate the herbicides. Plots were evaluated for injury and weed control on July 2 and then EPOST treatments applied. Plots were evaluated for injury again on July 6 and weed control and stand counts taken on July 9 and 10 respectively. Beans were harvested from 8.2 ft of row from the middle row of var. 5402. A composite sample of pods from all 4 replications of each treatment was graded.

Results. No differences were detected in plant stand between treatments or between the two varieties on July 7 after the EPOST treatments were applied (Table). A small amount of stunting was observed in some PRE treatments but overall variability was high in the plots and statistically significant differences between treatments were not evident. All PRE treatments provided 95% or better weed control.

Crop injury 5 days after the EPOST application indicated significant injury with Reflex applied EPOST after Dual Magnum and Reflex, and Dual Magnum followed by (fb) Raptor and Basagran. Weed control was exceptional with Reflex and Dual Magnum followed by (fb) Raptor and Basagran. Reflex provided better lambsquarters control at this site than at the Stayton site, but did not control lambsquarters when applied EPOST. The greatest yield was a tank mix of Reflex and Dual Magnum at the 1 pt rate of each. Yield followed weed control with the possible exception of Reflex PRE fb Sandea EPOST, indicating that Sandea may have seriously injured the beans.

Table 3. Herbicide application data for Exp. II

Date	Friday, June 14, 2013	Tuesday, July 02, 2013
Crop stage	Planted June 13	1.5 trifoliate
Weeds and growth stage		
Pigweed	-	≤6 lf and 1.5 in
Hairy nightshade	-	≤6 lf and 1.5 in
Lambsquarters	-	≤6 lf and 1.5 in
Purslane	-	≤6 lf and 1.5 in
Herbicide/treatment	PRE	EPOST
Application timing	PRE	EPOST
Start/end time	8:15-9:15AM	10-10:45AM
Air temp/soil temp (2")/surface	62/70/67	86/88/93
Rel humidity	65%	54%
Wind direction/velocity	0-2 N	NE 0-1
Cloud cover	0	0
Soil moisture	0	0
Plant moisture	0	0
Sprayer/PSI	BP CO2 30 PSI	BP CO2 30 PSI
Mix size	2100 mls	2100 mls
Gallons H20/acre	20	20
Nozzle type	6-XR8003	5-XR8003
Nozzle spacing and height	20/24	20/24
Soil inc. method/implement	Irrigate 6-16	Irrigate 7-5

Table 4. Crop and weed response to herbicides at midseason, Veg. Res. Farm, Corvallis, 2013.

	Herbicide	Timing	Rate		Emergence July 7		Phyto July 2 (3 WA)		Stunting July 2 (3 WA)		Weed control July 2, 2013					
					Var. 5402	Var. Savannah	Var. 5402	Var. Savannah	Var. 5402	Var. Savannah	Hairy nightshade	Pigweed	Lambsquarters	Purslane	Witch grass	Composite rating
			Prod/A	*lb ai/A*	*No/4 ft*		*0-10*		*%*		---------- *%* ----------					
1	Reflex	PRE	1 pt	0.25	27	30	0	0	4	3	97	99	99	100	100	97
2	Reflex	PRE	1 pt	0.25	26	33	0	0	10	15	100	100	100	100	100	100
	Dual Magnum	PRE	1 pt	0.956												
3	Reflex	PRE	2 pt	0.5	34	39	0	0	11	10	100	100	98	100	100	99
4	Reflex	PRE	2 pt	0.5	30	35	0	0	13	13	100	100	100	100	100	100
	Dual Magnum	PRE	1 pt	0.96												
5	Reflex	PRE	1 pt	0.25	31	35	0[a]	0[a]	3[a]	3[a]	96	100	98	100	100	97
	Raptor	EPOST	4 oz	0.031												
	Basagran	EPOST	1 pt	0.5												
6	Reflex	PRE	1 pt	0.25	28	33	0[a]	0[a]	13[a]	13[a]	98	98	98	100	100	99
	Dual Magnum	PRE	1 pt	0.96												
	Raptor	EPOST	4 oz	0.031												
	Basagran	EPOST	1 pt	0.5												
7	Raptor	EPOST	4 oz	0.031	23	37	-	-	-	-	-	-	-	-	-	-
	Basagran	EPOST	1 pt	0.5												
8	Dual Magnum	PRE	1 pt	0.96	27	32	0	0	10	8	95	100	100	100	100	98
	Sandea	PRE	1 oz	0.048												
9	Dual Magnum	PRE	1 pt	0.96	35	37	0[a]	0[a]	1[a]	8[a]	97	100	88	99	100	95
	Sandea	EPOST	1 oz	0.048												
10	Dual Magnum	PRE	1 pt	0.95	37	31	0[a]	0[a]	0[a]	0[a]	93	96	86	100	78	90
	Reflex	EPOST	1 pt	0.25												
11	Outlook	PRE	14 oz	0.66	31	39	0	0	5	10	99	99	98	100	100	98
12	Check	-	-	-	32	35	-	-	-	-	-	-	-	-	-	-
	FPLSD (0.05)				ns	ns	ns	ns	ns	ns	4	3	9	1	18	4

[a] *Injury recorded in the cells in this row on this date is due to the control provided by the PRE herbicide, as the EPOST was not applied yet.*

Table 5. Crop and weed response to herbicides midseason and harvest, Veg. Res. Farm, Corvallis, 2013.

	Herbicide	Timing	Rate		Phyto July 7 (5 DA EPOST)		Stunting July 7 (5 DA EPOST)		At harvest (August 16, 2013) Weed control							Yield	Grade
					Var. 5402	Var. Savannah	Var. 5402	Var. Savannah	Hairy nightshade	Pigweed	Lambsquarters	Purslane	Witch grass	Barnyardgrass	Composite rating		
			Prod/A	*lb ai/A*	*0-10*		*%*		---------- *%* ----------							*t/A*	*% 1-4*
1	Reflex	PRE	1 pt	0.25	0	0	3	0	85	95	89	100	100	45	75	7.8	55
2	Reflex	PRE	1 pt	0.25	0	0	3	0	97	100	95	100	100	100	93	9.1	40
	Dual Magnum	PRE	1 pt	0.956													
3	Reflex	PRE	2 pt	0.5	0	0	3	3	92	98	93	100	100	93	88	9.3	39
4	Reflex	PRE	2 pt	0.5	0	0	13	9	99	99	99	100	100	100	96	8.8	40
	Dual Magnum	PRE	1 pt	0.96													
5	Reflex	PRE	1 pt	0.25	0.9	0.6	13	13	100	100	98	100	100	89	94	9.4	49
	Raptor	EPOST	4oz	0.031													
	Basagran	EPOST	1 pt	0.5													
6	Reflex	PRE	1 pt	0.25	1.4	0	20	10	100	100	95	100	100	100	100	8.8	44
	Dual Magnum	PRE	1 pt	0.96													
	Raptor	EPOST	4oz	0.031													
	Basagran	EPOST	1 pt	0.5													
7	Raptor	EPOST	4oz	0.031	1.0	0.3	9	9	100	91	85	100	100	85	80	8.3	48
	Basagran	EPOST	1 pt	0.5													
8	Dual Magnum	PRE	1 pt	0.96	0.3	0.3	13	5	34	100	99	100	100	100	66	7.7	38
	Sandea	PRE	1 oz	0.048													
9	Dual Magnum	PRE	1 pt	0.96	5.0	4.0	30	25	85	100	73	100	100	100	78	6.5	49
	Sandea	EPOST	1 oz	0.048													
10	Dual Magnum	PRE	1 pt	0.95	0.9	0.5	0	1	99	99	58	100	100	100	68	7.4	49
	Reflex	EPOST	1 pt	0.25													
11	Outlook	PRE	14 oz	0.66	0	0	5	3	91	93	70	100	100	100	71	8.4	42
12	Check	-	-	-	0	0	0	0	0	0	0	0	0	0	0	1.5	41
	FPLSD (0.05)				0.5	0.6	9	13	9	8	13	0	0	22	10	2.2	-

Exp III. Edamame tolerance to Reflex and Spartan

Methods

S-metolachlor (Dual Magnum) was applied by the grower and incorporated. Edamame (var. Sayakomachi) was planted on May 6 with a Monosem planter. Experimental plots were 10 by 20 ft and treatments applied to plots in a completely randomized block design with 3 replications. Sulfentrazone (Spartan) and fomesafen (Reflex) treatments were applied PPS (post-plant surface) on May 7 with a CO_2 powered back pack sprayer at 30 PSI and delivery rate of 20 GPA. Weed control and crop injury were evaluated as the 1st trifoliate emerged and again at midseason. Edamame plants were pulled from 8.2 ft of row and pods stripped from plants and weighed, but not shelled.

Results

Crop injury was visible in two of the three replications in plots treated with Spartan at 12 oz/A (Table 3). However, one of these plots was in a low and wet area in the field, which may have exacerbated crop injury. No injury was noted with Reflex. Crop emergence may have been slightly reduced by the 2x rates of both Spartan and Reflex. No signs of crop injury were visible at the midseason rating (data not presented).There was very little statistical evidence that edamame yield was influenced by either Spartan or Reflex, but trends did suggest a possible suppression of pod yield at the 2x rates of both herbicides. Weeds were so scarce in this experiment that weed control ratings were not possible and weed competition with the crop was not a factor in determining yield.

Table 6. Herbicide application data for EXP III.

Date	Tuesday, May 07, 2013
Application timing	PPS
Start/end time	6:50-7:05 AM
Air temp	57
Rel humidity	65%
Wind direction/velocity	W 0-0.5
Cloud cover	0
Soil moisture	Dry, good moisture at 1 in
Sprayer/PSI	BP CO2 30 PSI
Mix size	2100
Gallons H20/acre	20
Nozzle type	8003
Nozzle spacing and height	20/20
Soil inc. method/implement	Irrigation on May 7 AM

Table 7. Effect of Spartan and Reflex on edamame, Keizer, OR, 2013.

	Herbicide	Timing	Rate		1st trifoliate emerging (May 31)		Harvest (August 28)				
					Crop injury rating	Emerg-ence	Plant count	Plant biomass	Average plant wt.	Pod yield	Pod wt.
			product	*lb ai/A*	*%*	*no/5 ft row*	*no/8.2ft*	*lb/plot*	*lb/plant*	*t/A*	*lb/100 pods*
1	Spartan	PRE	6 oz	0.1875	0	18	31	7.1	0.227	3.0	0.52
2	Spartan	PRE	12 oz	0.375	16[a]	16	31	7.0	0.213	2.8	0.47
3	Reflex	PRE	1 pt	0.25	0	17	32	6.8	0.216	3.2	0.56
4	Reflex	PRE	2 pt	0.5	0	16	31	6.5	0.210	2.9	0.52
5	Check	-	-	-	7 [a]	19	29	6.9	0.239	2.9	0.47
	ANOVA (Prob >F)				*0.50*	*0.12*	*0.21*	*0.94*	*0.89*	*0.85*	*0.29*
	FPLSD(0.05)				-	*3*	-	-	-	-	-

[a] Includes rating of 30% in the 2nd block of treatment 2 and a rating of 20% in one of three check plots, likely due to a low and wet area in the field.