

Evaluation of acifluorfen and fomesafen for lima bean safety, 2014 and 2015.

The experiment was conducted at the University of Delaware's Research and Education Center in both years. Plots were established in 2014 in a field of loamy sand soil (79:11:10 sand:silt:clay), 2.0% o.m. and 6.0 pH; and 2015 in a field of loamy sand soil (79:12:9 sand:silt:clay), 0.7% o.m. and 6.2 pH. The experiment was conducted as a randomized complete block design with 10 treatments and with three replications. Irrigation was used to reduce moisture stress. Fields were conventionally tilled with chisel plow and disk. Plots consisted of four 30-in. rows, 25 ft. long. Lima bean were planted June 10, 2014 and July 1, 2015 at 4 seeds/ft., planted 0.75 to 1 in. depth. Entire area was treated with 1 to 1.25 pts of Dual within 1 day of planting. Plots were not cultivated and no layby nitrogen was applied. Insecticide and fungicide applications were made as needed. Treatments consisted of herbicide application at first trifoliolate of lima bean with Ultra Blazer at 4, 8, and 16 fl oz/A, Reflex at 4 and 8 fl oz/A, and standard treatment of Raptor + Basagran. In addition, Ultra Blazer was applied at 8 or 16 fl oz/A, 21 days before lima bean harvest. All herbicide treatments include a non-ionic surfactant at 0.25 % v/v. In addition, a weedy and weed-free check was included. Weed-free check was treated with Basagran + Poast and followed up with hand-weeding. Herbicide applications were made with 20 g/A, at 3 mph, and 11002 spray nozzles. First trifoliolate applications were made with tractor sprayer using compressed air at 40 psi, while 21 DPH were applied with CO₂ backpack sprayer using 30 psi. Visual crop response and weed control were made based on appropriate check plots on a scale of 0 to 100. Area of the curve was calculated for lima bean stunting to assess crop recovery from herbicide damage. Stand counts were made in 2014, 2 weeks after treatment. At harvest, four plants per plot were randomly sampled for number of flat, plump, and dry pods. Higher percentage of flat or dry pods indicate delayed or increased maturity, respectively. Twenty feet of row were harvested for yield. Entire plants were pulled and put in a viner/sheller to remove seeds from pods. Final yield was determined as lbs/A.

Data was combined over years when treatment by year interaction was not significant, otherwise data was analyzed and present by year. Treatments with either Ultra Blazer or Reflex applied at first trifoliolate had significant leaf burn, and resulted in stunted plants. Application at 21 days pre-harvest did not result in leaf burn or stunting, but weed control was very poor with this treatment due to poor coverage, as a result of lima bean growth and weeds were too large for adequate control (data not presented). Plants were slow to recover from the early treatments as determined with recovery values (AUC). There was a stepwise increased effect for each of the products rate as the rate increased.

Effect of treatments on injury. Injury included initial leaf burn, stunting, and recover (as calculated with area under the curve [AUC]).

Herbicide ¹	Rate/A	Timing ^z	Lf (3 d)		Stunt			Recovery
			Burn		1 wk	2 wk	3 wk	AUC
			2014	2015				
Untreated			0	0	0	0	0	0
Ultra Blazer + NIS ²	4 fl oz	1 st Trifol	50 c	27 c	52 b	43 bc	31 c	1307 c
Ultra Blazer + NIS ²	8 fl oz	1 st Trifol	53 bc	43 b	61 a	53 b	40 b	1628 b
Ultra Blazer + NIS ²	16 fl oz	1 st Trifol	60 ab	63 a	63 a	68 a	58 a	2291 a
Reflex + NIS ²	4 fl oz	1 st Trifol	63 a	16 d	40 c	29 d	26 c	1085 c
Reflex + NIS ²	8 fl oz	1 st Trifol	33 d	27 c	50 b	41 c	44 b	1706 b
Raptor + Basagran + NIS ²	4 + 16 fl oz	1 st Trifol	6 e	0 e	8 d	7 e	7 d	257 d
Ultra Blazer + NIS ²	8 fl oz	21 DPH	--	--	--	--	--	0 d
Ultra Blazer + NIS ²	16 fl oz	21 DPH	--	--	--	--	--	0 d
<i>P</i> ^{x>F}			0.000	0.0001	0.0001	0.000	0.000	0.0001
			1			1	1	

¹Ultra Blazer= acifluorfen; Reflex= fomesafen; Raptor= imazamox; Basagran= bentazon

²NIS= non-ionic surfactant at 0.25% v/v

-- means treatments not yet applied

^zApplication timing for 1st trifoliolate was Jun 27, 2014 and Jul 15, 2015; and 21 day pre-harvest (21 DPH) Aug 7, 2014 and Aug 27, 2015

^yMeans within a column followed by the same letter are not significantly different (*p*=0.05) according to Fisher's protected LSD test.

^x*P* values ≤0.05 indicate significant differences exist among treatments.

In 2014, Raptor or the late applications of Ultra Blazer had similar yields to the weed-free check. Weed density was low in 2014, and as a result yield loss was primarily due to herbicide injury, not weed competition. In 2015, yield was similar to the weed-free checks, except Ultra Blazer at 8 fl oz applied early and 21 days pre-harvest. Weed densities were high in 2015 and yield with late applications of Ultra Blazer were impacted by weed competition. So yield loss cannot be attributed to herbicide injury. The percent flat pods is in indication of delayed maturity, while increased dry pods would indicate early maturing plants. But treatments did not impact crop maturity.

Effect of treatments on yield and yield components, percent of pods with plump seeds, flat pods or dry pods based on four randomly selected plants.

Herbicide ¹	Rate/A	Timing ^z	Yield (lbs/A)		Plump (%)		Flat (%)		Dry (%)	
			2014	2015	2014	2015	2014	2015	2014	2015
Untreated			--	1866 abc	--	88 a	--	8 a	--	4 a
Ultra Blazer + NIS ²	4 fl oz	1 st Trifol	--	1640 abc	--	84 a	--	10 a	--	6 a
Ultra Blazer + NIS ²	8 fl oz	1 st Trifol	2800 cd	1307 cd	71 a	90 a	27 a	9 a	2 a	1 a
Ultra Blazer + NIS ²	16 fl oz	1 st Trifol	2346 d	1460 bcd	56 a	91 a	32 a	9 a	8 a	0 a
Reflex + NIS ²	4 fl oz	1 st Trifol	--	1577 a-d	--	88 a	--	9 a	--	3 a
Reflex + NIS ²	8 fl oz	1 st Trifol	3064 bcd	2150 a	69 a	91 a	19 a	3 a	10 a	6 a
Raptor + Basagran + NIS ²	4+16 fl oz	1 st Trifol	5029 a	1999 ab	66 a	90 a	6 a	4 a	24 a	6 a
Ultra Blazer + NIS ²	8 fl oz	21 DPH	4241 abc	972 d	57 a	89 a	13 a	3 a	28 a	8 a
Ultra Blazer + NIS ²	16 fl oz	21 DPH	3604 a-d	1620 abc	64 a	90 a	12 a	2 a	23 a	7 a
Weed-free Check			4478 ab	2066 ab	72 a	81 a	9 a	14 a	17 a	4 a
<i>P>.F</i>			0.0193	0.0202	0.736	0.8828	0.0723	0.5055	0.0515	0.3408

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-- means data not collected

^zApplication timing for 1st trifoliolate was Jun 27, 2014 and Jul 15, 2015; and 21 day pre-harvest (21 DPH) Aug 7, 2014 and Aug 27, 2015

^yMeans within a column followed by the same letter are not significantly different ($p=0.05$) according to Fisher's protected LSD test.

*P values ≤ 0.05 indicate significant differences exist among treatments.

Treatments at 21 days after planting resulted in significant injury, but lima beans were able to produce yields similar to the weed-free check. However, the amount of injury, leaf burn and stunting, was not commercially acceptable. Late applications had little impact on injury and yield, but this timing resulted in unacceptable weed control. Other research with Ultra Blazer has consistently shown that effectiveness decreases when applied to weeds over 3 inches tall. Ultra Blazer is an effective herbicide only on small (3 inches tall or less) and has little to no impact as a "rescue" treatment on large weed. Furthermore, research needs to determine if weeds at susceptible sizes at the late application timing warrant the need for an herbicide application.

This trial was conducted as a preliminary crop safety trial. Neither Ultra Blazer nor Reflex are labeled for use on lima beans (as of November 2015).