

Research Report to the
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Title. Snap Bean Tolerance to Imazamox

Project Leaders: R. Ed Peachey and R. D. William, Horticulture Department, OSU; Dan McGrath, Marion County Extension

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Summary

I. Herbicide Effects on Snap Bean Emergence, Growth and Root Health (Corvallis)

- Cobra is likely to cause more injury to beans than Dual or Eptam in light soils.
- Imazamox is less likely to injure snap beans than other soil applied herbicides.
- A registration for imazamox would greatly reduce the risk of crop injury associated with reliance on soil applied herbicides.

II. Influence of Timing, Rate, Surfactant, and Basagran on Snap Bean Tolerance to Imazamox (Corvallis)

- Imazamox did not reduce yield when applied to snap beans at the 1st and 2nd trifoliolate at 0.024 to 0.032 lb ai/A.
- Basagran tankmixed with imazamox significantly improved crop safety
- Snap bean growth stage was more important than imazamox rate in determining snap bean yield.
- Choice of surfactant may have influenced imazamox injury
- Injury was greater with late afternoon applications

III. Weed Control with Imazamox (Independence)

- Control of pigweed 5 WAP ranged from 92-100 percent with imazamox alone or in combination with other herbicides.
- Tankmixes with Basagran greatly improved lambsquarter control but reduced control of pigweed and witchgrass.
- Imazamox applied before the 1st trifoliolate had fully opened did not provide full season weed control.
- Imazamox with either Dual or Eptam provided exceptional control of nearly every species present.

IV. Potential of Imazamox as a Rescue Treatment (Mt. Angel)

- Pigweed control was exceptional with imazamox at all application timings.
- Lambsquarters control was greatly improved by tankmixing Basagran
- The treatment with the best weed control was Basagran applied at the first trifoliolate and imazamox applied at 1st bloom.
- The sequential application of imazamox and Basagran may be justified in fields such as these where lambsquarter populations are large.

I. Herbicide Effects on Snap Bean Emergence, Growth and Root Health

Methods

Soil in this trial was a sandy loam with 3% OM and CEC of 15.6 meq/100 g soil. The seedbed was prepared on April 29 by disking and rototilling. Mocap and Eptam were applied to plots and incorporated with a vertical tine tiller. Fertilizer was banded at 400 lbs (12-29-10)/A at planting on May 6. Dual and Cobra were applied after planting. Rainfall incorporated the herbicide immediately after planting. Additional irrigation water was applied as the crop emerged to simulate very wet conditions. The plots were cultivated and hand hoed to remove as many weed escapes as possible without disturbing the bean plants. Poast herbicide was applied mid-season to control barnyardgrass. Snap beans were harvested from 8.2 ft of row in each plot on July 24. A representative sample of bean pods from each treatment was graded.

Results and Discussion

Main effect means were compared for each variable (Table 1). While differences were apparent for many of the herbicides, caution must be exercised interpreting this data. Several means did not conform to the general pattern described by the main effect means and will be discussed separately.

Emergence was possibly reduced by Cobra (Table 2). The growth reduction estimate indicated that Cobra and Dual reduced bean growth 126 and 40 percent, respectively, while there was little or no change for imazamox treatments. Root mass ratings for treatments with Eptam were slightly lower than for treatments that did not have Eptam. Eptam may have increased root lesions. Adventitious root development was less for treatments with imazamox. Eptam reduced the tap root rating by 14 percent.

Yields were below average because of the extended cool season in May (Table 2). Plant populations at harvest averaged slightly less in Mocap treatments while snap bean biomass averaged less in Cobra treatments at harvest. Yield did not correlate closely with any of the factors, but a trend was noted with the number of pesticides applied. The greater the number of pesticides, the greater injury to snap beans (Figure 1).

Imazamox plus Eptam yielded the most beans, probably because this combination controlled weeds very well. Hoeing was extensive in some plots and may have reduced yield. Hoeing and cultivation may have reduced yields in plots with only imazamox applied; imazamox did not control abundant dog fennel at this site.

While imazamox had no cumulative effect on plant growth at midseason, one treatment stands out. Applying imazamox to beans treated with Eptam + Cobra + Mocap increased the growth reduction estimate from 33 to 60 percent. This treatment also yielded poorly (7.5 t/A).

Conclusion

Imazamox is less likely to injure snap beans than other soil applied herbicides when applied in early spring. Fewer deleterious effects on bean roots were noted with imazamox. Cobra injury was significant at mid-season but did not translate to reduced yield. The number of soil applied herbicides used on early season beans should be kept at a minimum. A registration

for imazamox would minimize much of the risk associated with reliance on soil applied herbicides for weed control in snap beans.

II. Influence of Timing, Rate, Surfactant, and Basagran on Snap Bean Tolerance to Imazamox

Methods

Snap beans were planted on May 27 on 30 inch rows with banded fertilizer. Dual herbicide was applied following planting at 1 lb ai/A. The plots were cultivated twice to minimize weed competition. Plots without herbicides were hand hoed once. Snap beans were harvested from 8.2 ft of row from each plot on August 1, beans stripped by hand, and pods graded.

Results and discussion

Injury and phytotoxicity (Table 4). Snap beans were injured most when imazamox was applied at the 1st trifoliolate. Symptoms dissipated within a few days, with the exception of imazamox at 0.04 lb ai/A applied to 1st trifoliolate beans. Both snap bean growth stage (trifoliolate) and imazamox rate were important variables determining the phytotoxicity rating 5 WAP^a. Neither factor had an effect on snap bean growth estimates 5 WAP.

Non-ionic surfactant (NIS) increased crop injury when applied at the 1st trifoliolate, but not at the 2nd or third trifoliolate. Crop oil concentrate (COC), metholayed seed oil (MSO), and organo-silicone (OS) surfactants also increased injury when applied with imazamox at the 2nd trifoliolate, similar to injury with NIS. The exception was the non-ionic surfactant X-77 which may have diminished imazamox injury. Applying imazamox in late afternoon increased imazamox injury symptoms on snap beans.

Tankmixing Basagran with imazamox improved crop safety even when applied with COC or at rates as high as 0.064 lb ai/A.

Snap bean yield was primarily determined by snap bean growth stage at the time of the imazamox application rather than herbicide rate (Table 5, Fig. 1). The effect of imazamox on snap bean yield was inconsistent across rate and timing of application, however. Yield and value increased along with imazamox rate when applied at the second trifoliolate, but not at the first and third trifoliolate.

Analysis of variance of projected yields^b indicated that imazamox application timing was not a significant factor determining snap bean yield. The effect of imazamox application timing on projected yields dissipated because this analysis accounted for possible delays in maturity induced by imazamox. This was verified by a 2nd harvest 4 days after the first harvest (Table 3) of treatments that had lower than average yield. Although there was injury to snap beans from imazamox, maturity was delayed by 2-4 days but not reduced.

^a Factorial analysis of variance with timing and rate as main effects.

^b Projected yield weighted by grade that was estimated from a regression equation of yield and grade across all plots.

Yields were from 1.4 to 2.2 tons/A greater when surfactants (COC, MSO, OS, and X-77) were applied with imazamox at the 2nd trifoliolate stage of beans. This may have been due to improved weed control. Even though Dual was applied PES and plots cultivated twice and hand hoed, a sizable cohort of hairy nightshade survived in some treatments, particularly if weeds were shaded by snap beans in the row. The effect of poor weed control on yield is also evident in the Basagran check.

Late afternoon applications of imazamox reduced snap bean yield slightly at 0.032 lb ai/A but by 28 percent at 0.040 lb ai/A when applied at the second trifoliolate. However, yield was delayed as indicated by grade; projected yields based on grade indicated very little difference in potential yield.

Basagran tankmixed with imazamox improved crop safety and possibly yield. Actual and projected yields indicated that all of the treatments with Basagran (Trs. 20-24) yielded as much or greater than the same treatment without Basagran. Even imazamox at 0.064 lb ai/A did not have a significant effect on snap bean yield.

III. Weed Control with Imazamox

Methods

Eptam was applied to designated plots and incorporated with a rototiller within 15 minutes on June 21. Snap beans were planted on June 21 and Dual and Cobra applied and incorporated with 0.5 in of irrigation water within 4 hours of application. Imazamox treatments were applied at three times: as the first trifoliolate was opening (designated 'Pre 1st' in Table 9); the 2nd trifoliolate was just beginning to open (1st tri); and when the 2nd trifoliolate was fully expanded and the third trifoliolate beginning to emerge (2nd tri⁺). Pigweed and lambsquarters were 4-6 inches tall at the 2nd tri⁺ application timing. Two treatments with imazamox tankmixed with Poast and Assure were included to test the potential of improving imazamox grass control with these ALS inhibitors. Summer annual weeds were removed from these plots by hoeing to better evaluate the impact on wild proso millet and witchgrass. Untreated check strips were left between the blocks to use as a comparison for weed control ratings.

Results and discussion

Control of pigweed 5 WAP ranged from 92-100 percent with imazamox alone or in combination with other herbicides (Table 8). Pigweed was the primary weed at this site. Although tankmixes with Basagran greatly improved lambsquarter control, Basagran tankmixed with imazamox generally reduced control of pigweed and witchgrass. Purslane control improved with the Basagran tankmix.

Imazamox applied before the 1st trifoliolate fully emerged at 0.016 lb ai/A was sufficient for early season weed control, whether applied with or without Basagran (Table 9). However, snap beans were less tolerant of imazamox at this stage of growth than when applied later.

Imazamox applied at 0.016 lb ai/A before the first trifoliolate was fully expanded did not provide season long weed control. Imazamox applied alone to 1st trifoliolate beans did not adequately control weeds even though weed control was good to excellent at midseason.

Applying imazamox sequentially after any of the soil applied herbicides provided exceptional control of nearly every species present. Particularly successful were Dual or Eptam followed by imazamox at 2nd+ trifoliolate stage of beans (Fig. 3). Basagran plus Poast had very poor weed control compared to the single application of imazamox and Basagran at the 2nd+ trifoliolate. Pigweed and lambsquarter were 4-6 inches tall when imazamox was applied to 2nd+ trifoliolate beans. Wild proso millet control may have been better with imazamox +Poast than imazamox +Assure (100% vs. 88% control: data not shown in table) although the population was highly variable. There was no difference between the Poast and Assure treatments for witchgrass control.

Snap beans were very tolerant to imazamox when applied after the 1st trifoliolate. Pod yield was greatest with Dual and imazamox. Yields were less in the early application treatments probably because of weed competition. Yield of Trs. 3 and 4 were lower than predicted in regression on weed control at harvest. This may have been due to crop injury from imazamox as much as weed competition.

IV. Potential of Imazamox as a Rescue Treatment

Methods

Snap beans (var. OR91G and Hercules) were planted on June 1 after Eptam herbicide was incorporated into the soil. Dual herbicide was banded over the row. Due to rainy and wet condition after planting, the herbicides did not effectively control weeds and a large population of pigweed and nightshade was present. This provided a good opportunity to test postemergence imazamox as a rescue treatment. Three replications were set in the OR91G with plot sizes 10 x 25. One replication of treatments 1-6 were placed in the Hercules variety with plot size 10 x 40. Imazamox with and without Basagran was applied to the plots on June 22, 28, and July 12 to 1st and 2nd trifoliolate beans and beans at first bloom. Weed control and injury ratings were made on July 12, 19 and August 4.

Results

Weed control. Pigweed control with imazamox was exceptional at all application timings (Table 11). Lambsquarters control was primarily related to whether Basagran was tankmixed with imazamox. The treatment with the best weed control was Basagran applied at the first trifoliolate and imazamox applied at 1st bloom. Basagran removed all of the lambsquarters when there were 4 leaves or less present; the imazamox easily killed the remaining pigweed. However, this treatment also had significant injury symptoms at midseason. Yield was not taken in this trial and it is unclear whether this treatment reduced yield. The sequential application of imazamox and Basagran may be justified in fields such as these where lambsquarter populations are large.

Crop injury from imazamox applied to 1st trifoliolate beans was minimal 2 WAT. Injury was more severe when applied to 2nd trifoliolate beans, although there were large unexplained differences in injury between plots. The June 28 application was applied at midday with air temp. at 74 F and humidity at 60 % (Table 12). Basagran tankmixed with imazamox reduced injury symptoms on snap beans. Imazamox applied sequentially after Basagran produced moderate injury symptoms as the safening effect of Basagran was lost in the sequential

application. There were no apparent differences between the two varieties for tolerance to imazamox.

Table 1. Main effects of herbicide on measured variables when averaged across all treatments, Corvallis, 2000.

Herbicide main effect	Emergence	Growth reduction (4 WAP)	Root mass rating	Lesions	Adventitious root development	Taproot development	Plant population	Biomass at harvest	Pod yield
	No/m	%	5=good.	5=many	5=many	5=good	No./A	t/A	t/A
Dual									
-	20.9	24.7	2.9	2.8	1.8	2.9	101000	14.8	8.8
+	22.0	34.5	3.0	2.5	1.9	2.8	99000	14.4	8.6
% change	5.2	39.7***	4.3	-8.3	5.7	-3.6	-2.0	-2.5	-2.6
Eptam									
-	22.0	27.9	3.1	2.4	1.8	3.1	98000	14.9	8.8
+	20.9	31.3	2.8	2.9	1.9	2.6	101000	14.3	8.6
% change	-5.1	11.9	-9.3*	23.9*	5.7	-14.2**	3.1	-4.4	-3.3
Mocap									
-	21.7	26.8	3.1	2.7	1.8	2.9	102000	14.5	8.6
+	21.2	32.4	2.9	2.6	1.9	2.8	98000	14.7	8.8
% change	-2.3	21.0*	-5.4	-2.3	3.4	-3.6	-3.9*	1.2	3.0
Cobra									
-	22.1	18.1	3.1	2.5	1.8	2.9	100000	15.0	8.8
+	20.8	41.0	2.9	2.8	2.0	2.8	99000	14.2	8.6
% change	-6.0*	126.4***	-5.4	12.6	13.1	-3.6	-1.0	-5.7*	-3.0
Imazamox									
-	21.2	29.4	3.0	3.0	2.1	3.0	98000	14.3	8.6
+	21.7	29.8	2.9	2.3	1.7	2.8	101000	14.9	8.8
% change	2.2	1.4	-2.8	-24.3***	-19.2**	-7.7	3.1	4.3	2.9

Probability of difference between main effect means: * $P \leq .15$, ** $P \leq .05$, *** $P \leq .01$

Table 2. Herbicide effects on snap bean (OR91G) growth and yield, Corvallis, 2000.

	Herbicide and timing					Plant survival 7 WAP	Growth reduction estimate 9 WAP	Root health rating (9 WAP)				Harvest			
	PES	PPI	PPI	PES	2nd trifoliolate			Root mass	Lesions	Adventitious roots	Tap root	Plant population	plant biomass	pod yield	grade
	1=poor/few, 5=excellent/many												no/A	t/A	t/A
1	Dual	Eptam	Mocap	Cobra	Imazamox	27	33	2.0	2.3	1.3	2.0	91000	12.1	7.3	26%
2	Dual	Eptam		Cobra	Imazamox	19	43	2.7	3.3	2.0	1.3	118000	12.2	7.6	19%
3	Dual	Eptam	Mocap		Imazamox	21	37	2.7	1.7	1.3	3.0	110000	15.1	8.9	22%
4	Dual	Eptam			Imazamox	20	17	2.7	2.7	1.0	2.3	104000	14.6	8.5	29%
5	Dual	Eptam	Mocap	Cobra		19	43	2.7	3.7	3.0	3.0	90000	12.4	7.6	22%
6	Dual	Eptam		Cobra		23	43	2.3	2.3	2.7	2.7	122000	13.9	8.6	21%
7	Dual	Eptam	Mocap			21	25	4.0	2.7	2.3	2.3	99000	14.5	9.1	17%
8	Dual	Eptam				22	27	3.3	3.7	2.3	2.7	100000	15.6	8.4	18%
9	Dual		Mocap	Cobra	Imazamox	19	50	3.0	2.3	2.7	2.7	100000	12.9	7.8	20%
10	Dual			Cobra	Imazamox	21	43	3.3	2.0	1.3	3.0	99000	15.1	9.0	24%
11	Dual		Mocap		Imazamox	27	20	3.0	1.0	1.7	3.7	110000	17.3	10.1	22%
12	Dual				Imazamox	25	30	3.7	2.7	1.7	2.0	88000	14.8	8.5	26%
13	Dual		Mocap	Cobra		20	43	3.7	3.3	1.3	3.3	90000	13.7	8.0	22%
14	Dual			Cobra		23	50	3.0	1.3	1.3	4.0	99000	16.2	9.8	20%
15	Dual		Mocap			20	33	3.0	2.3	2.3	3.3	94000	15.7	9.7	17%
16	Dual					24	13	3.7	3.0	2.3	3.7	104000	14.5	8.5	19%
17		Eptam	Mocap	Cobra	Imazamox	15	63	2.0	2.3	2.3	1.3	93000	12.2	7.5	17%
18		Eptam		Cobra	Imazamox	20	33	3.0	3.0	1.7	3.3	113000	16.1	9.7	25%
19		Eptam	Mocap		Imazamox	22	20	3.7	2.7	2.0	3.7	105000	17.1	10.0	21%
20		Eptam			Imazamox	24	3	3.0	2.0	1.7	3.0	109000	17.7	10.4	19%
21		Eptam	Mocap	Cobra		24	33	3.7	3.0	1.0	3.7	111000	16.4	10.2	20%
22		Eptam		Cobra		18	40	2.7	4.3	2.3	2.7	105000	13.9	8.6	21%
23		Eptam	Mocap			18	23	2.3	4.0	2.0	2.0	94000	12.9	7.7	19%
24		Eptam				22	15	2.7	3.0	1.7	3.3	99000	11.5	6.8	19%
25			Mocap	Cobra	Imazamox	20	37	2.7	2.7	1.7	2.7	94000	15.6	9.3	21%
26				Cobra	Imazamox	23	30	3.3	1.7	1.3	4.0	101000	15.4	9.1	23%
27			Mocap		Imazamox	24	10	3.0	2.0	1.3	3.0	113000	17.1	10.1	20%
28					Imazamox	20	7	3.3	2.0	1.7	3.0	115000	13.2	7.4	21%
29			Mocap	Cobra		18	37	2.7	3.3	3.0	2.3	108000	15.3	9.2	21%
30				Cobra		24	33	3.7	3.7	2.7	3.0	96000	13.2	7.9	22%
31			Mocap			24	10	2.3	2.3	1.0	3.0	95000	14.7	8.7	19%
32	Check					20	0	2.7	2.0	1.7	2.7	105000	14.2	8.4	18%
	LSD 0.05					6	28	1.4	2.2	1.6	1.7	2000	1.8	1.2	-

Table 3. Schedule and herbicide application data, Corvallis, 2000

Activities				
May 6	PPI herbicides			
	Planting	OR 91G, fertilizer banded at 363 lb 12-29-10		
May 7	PES herbicides			
June 13	Imazamox			
Harvest	July 24			
Soil data				
	Type	pH	OM	CEC
	silt loam	na	3.09	15.6
Plot size/exp. design	10 by 25'	3 reps	RCBD	
Proceeding crop	Snap beans			
Herbicide application data				
Herbicide/treatment	EPTC	Dual	Imazamox	
	Mocap	Cobra		
Application date	5-6-00	5-7-00	6-13-00	
Application timing	PPI	PES	POST 2 nd trifoliolate	
Start/end time	2:30-4 PM	6-7:30 PM	11:15-12	
Air temp/soil temp (2")/surface	67/74/87	63/63/63	68/79/88	
Rel humidity	60	62	80	
Wind direction/velocity	2-4 N	0-3 N	SW 0-1	
Cloud cover	0	0	0	
Soil moisture	Damp	Damp	Damp-wet	
Plant moisture	-	-	Dry	
Sprayer/PSI	BP CO ₂ /30	BP CO ₂ /30	BP CO ₂ /30	
Mix size	2.8 gal	2.8 gal	2.8 gal	
Gallons H ₂ O/acre	20	20	20	
Nozzle type	8003	8003	8003	
Nozzle spacing and height	20/18	20/18	20/18	
Soil inc. method/implement	Rotera (H)	Rain	-	

Table 4. Effect of timing, rate, Basagran, and surfactant on snap bean (OR91G) tolerance to imazamox, Corvallis, 2000.

Herbicide	Timing	Trifoliolate	Date	Rate	Growth reduction		Phytotoxicity rating	
					26-Jun	1-Jul	26-Jun	1-Jul
					lb ai/A	%	1-10 (10=all leaves affected)	
RATE and TIMING								
1 Imazamox NIS	8 AM	1st	19-Jun	0.024 0.25%	23	6	5.2	0.8
2 Imazamox NIS	8 AM	2nd	23-Jun	0.024 0.25%	5	3	2.8	1.2
3 Imazamox NIS	8 AM	3rd	27-Jun	0.024 0.25%	NA	3	NA	1.2
4 Imazamox NIS	8 AM	1st	19-Jun	0.032 0.25%	16	4	5	0.7
5 Imazamox NIS	8 AM	2nd	23-Jun	0.032 0.25%	8	6	4.2	2
6 Imazamox NIS	8 AM	3rd	27-Jun	0.032 0.25%	NA	11	NA	2.8
7 Imazamox NIS	8 AM	1st	19-Jun	0.04 0.25%	26	11	6	1
8 Imazamox NIS	8 AM	2nd	23-Jun	0.04 0.25%	5	4	4.8	2.4
9 Imazamox NIS	8 AM	3rd	27-Jun	0.04 0.25%	NA	8	NA	2.6
WITHOUT NIS								
10 Imazamox	8 AM	1st	19-Jun	0.024	7	0	2.8	0.2
11 Imazamox	8 AM	2nd	23-Jun	0.024	6	9	2.8	1.4
12 Imazamox	8 AM	3rd	27-Jun	0.024	NA	0	NA	1.4
AM vs. PM								
13 Imazamox NIS	3 PM	2nd	23-Jun	0.024 0.25%	23	26	6.2	3.6
14 Imazamox NIS	3 PM	2nd	23-Jun	0.032 0.25%	17	32	5.6	4.2
15 Imazamox NIS	3 PM	2nd	23-Jun	0.040 0.25%	28	38	7.4	5

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Table 4 cont'd

Herbicide	Timing	Trifoliolate	Date	Rate	Growth reduction		Phytotoxicity rating		
					26-Jun	30-Jun	26-Jun	30-Jun	
					lb ai/A	%	1-10 (10=all leaves affected)		
SURFACTANT COMPARISON									
16 Imazamox COC	8 AM	2nd	23-Jun	0.024 1.00%	9	4	3.2	1.4	
17 Imazamox Hasten(MSO)	8 AM	2nd	23-Jun	0.024 0.25%	6	8	2.8	1.6	
18 Imazamox Organo silicone	8 AM	2nd	23-Jun	0.024 0.25%	8	10	3	2	
19 Imazamox X-77	8 AM	2nd	23-Jun	0.024 0.25%	1	0	2.2	1.4	
BENTAZON									
20 Imazamox Bentazon NIS	8 AM	2nd	23-Jun	0.024 0.75 0.25%	7	4	1.6	1.2	
21 Imazamox Bentazon COC	8 AM	2nd	23-Jun	0.024 0.75 1.00%	2	3	2	0.8	
22 Imazamox Bentazon	8 AM	2nd	23-Jun	0.024 0.75	2	1	1.2	1.6	
23 Imazamox Bentazon	8 AM	2nd	23-Jun	0.032 0.75	4	4	1.8	2.2	
24 Imazamox Bentazon	8 AM	2nd	23-Jun	0.064 0.75	9	10	4.2	2.4	
CHECKS									
25 NIS	8 AM	2nd	23-Jun	0.25%	0	1	0	0	
26 COC	8 AM	2nd	23-Jun	1.00%	0	0	0	0	
27 Osilicone	8 AM	2nd	23-Jun	0.25%	0	0	0.1	0.6	
28 X-77	8 AM	2nd	23-Jun	0.25%	0	0	0.1	0.1	
29 Bentazon COC		2nd	23-Jun	0.75 1.00%	0	0	0	0.1	
30 None					0	0	0	0	
FPLSD _{0.05}						9	10	1.4	0.8

Table 5. Tolerance of OR91G snap beans to imazamox, Corvallis, 2000.

Herbicide	Timing	Tri- foliate	Rate	N	Plant population	Avg. plant wt.	Plant biomass	Pod yield	Projected pod yield	Grade	Value
			lb ai/A		No./A	g	t/A	-----t/A-----		% 1-4 sieve	\$/A
RATE AND TIMING											
1 Imazamox NIS	8 AM	1st	0.024 0.25%	5	105800	174	20.2	7.9	8.0	77%	\$ 1,715
2 Imazamox NIS	8 AM	2nd	0.024 0.25%	5	101700	181	20.2	7.2	7.9	80%	\$ 1,603
3 Imazamox NIS	8 AM	3rd	0.024 0.25%	5	116700	163	20.9	8.0	8.0	76%	\$ 1,730
4 Imazamox NIS	8 AM	1st	0.032 0.25%	5	105100	192	22.0	9.5	8.0	67%	\$ 1,909
5 Imazamox NIS	8 AM	2nd	0.032 0.25%	5	96700	194	20.6	8.3	9.0	80%	\$ 1,855
6 Imazamox NIS	8 AM	3rd	0.032 0.25%	5	110100	152	18.4	6.0	7.8	87%	\$ 1,428
7 Imazamox NIS	8 AM	1st	0.04 0.25%	5	102600	172	19.4	7.3	8.1	81%	\$ 1,634
8 Imazamox NIS	8 AM	2nd	0.04 0.25%	5	106700	182	21.3	9.2	8.9	74%	\$ 1,979
9 Imazamox NIS	8 AM	3rd	0.04 0.25%	5	106200	150	17.4	5.9	6.7	81%	\$ 1,300
WITHOUT NIS											
10 Imazamox	8 AM	1st	0.024	5	111500	180	21.7	9.3	8.0	69%	\$ 1,897
11 Imazamox	8 AM	2nd	0.024	5	110200	162	19.6	6.9	7.8	81%	\$ 1,581
12 Imazamox	8 AM	3rd	0.024	5	95500	187	19.6	8.4	7.5	70%	\$ 1,724
AM vs. PM											
13 Imazamox NIS	3 PM	2nd	0.024 0.25%	5	101300	167	18.6	7.4	8.5	83%	\$ 1,708
14 Imazamox NIS	3 PM	2nd	0.032 0.25%	5	108700	162	19.3	7.9	9.1	84%	\$ 1,827
15 Imazamox NIS	3 PM	2nd	0.040 0.25%	5	102200	166	18.4	6.6	8.5	88%	\$ 1,578

Table 5 cont'd

Herbicide	Timing	Tri- foliate	Rate	N	Plant population	Avg. plant wt.	Plant biomass	Pod yield	Projected yield	Grade	Value
			lb ai/A		No./A	g	t/A	-----t/A-----		% 1-4 sieve	\$/A
SURFACTANT COMPARISON											
16 Imazamox COC	8 AM	2nd	0.024 1.00%	5	93000	203	20.4	8.3	8.4	77%	\$ 1,835
17 Imazamox Hasten(MSO)	8 AM	2nd	0.024 0.25%	5	108000	176	20.8	8.4	8.6	77%	\$ 1,830
18 Imazamox Organo silicone	8 AM	2nd	0.024 0.25%	5	105000	175	20.2	9.1	8.6	73%	\$ 1,929
19 Imazamox X-77	8 AM	2nd	0.024 0.25%	5	103000	193	21.7	8.6	8.6	76%	\$ 1,856
BENTAZON											
20 Imazamox Bentazon NIS	8 AM	2nd	0.024 0.75 0.25%	5	103200	177	20.3	9.0	8.0	70%	\$ 1,853
21 Imazamox Bentazon COC	8 AM	2nd	0.024 0.75 1.00%	5	102900	186	20.6	8.0	8.4	79%	\$ 1,779
22 Imazamox Bentazon	8 AM	2nd	0.024 0.75	5	105500	169	19.6	6.9	7.8	82%	\$ 1,569
23 Imazamox Bentazon	8 AM	2nd	0.032 0.75	5	106400	180	20.8	8.7	7.5	69%	\$ 1,793
24 Imazamox Bentazon	8 AM	2nd	0.064 0.75	5	100500	184	20.2	8.1	7.9	75%	\$ 1,752
CHECKS											
25 NIS	8 AM	2nd	0.25%	5	88000	184	17.9	6.6	6.0	72%	\$ 1,399
26 COC	8 AM	2nd	1.00%								
27 Organo silicone	8 AM	2nd	0.25%								
28 X-77	8 AM	2nd	0.25%								
29 Bentazon COC		2nd	0.75 1.00%	5	91700	200	19.2	7.1	6.7	74%	\$ 1,537
30 None				5	114800	169	21.2	8.9	8.1	71%	\$ 1,799
FPLSD _{0.05}					ns	31	2.7	2.3	1.7	12%	\$ 400
CV(%)					13	14	11	24	17	12	19

Table 6. Imazamox effects on yield of snap beans (OR91G) at the second harvest, Corvallis.

Herbicide	Timing	Trifoliolate	Rate	N	Plant population	Avg. plant wt.	Plant biomass	Pod yield	Grade	Value
			lb ai/A		No./A	g	t/A	t/A	% 1-4 sieve	\$/A
2 Imazamox NIS	8 AM	2nd	0.024 0.25%	5	104000	213	24.0	11.1	61%	\$ 2,147
6 Imazamox NIS	8 AM	3rd	0.032 0.25%	5	90170	217	21.0	10.2	67%	\$ 2,052
9 Imazamox NIS	8 AM	3rd	0.04	5	108000	186	21.9	9.7	68%	\$ 1,996

Table 7. Schedule and herbicide application data, Corvallis, 2000

Activities				
Soil prep	Plowed and prepared seedbed with vertical tiller (2x) and rolled on last pass			
May 27	Planting	<ul style="list-style-type: none"> • OR 91G variety • Mocap banded 10 lb ai/A in a 12 inch band • Fertilizer banded @ 350 Lbs 12-29-10 at planting • Dual applied to all plots after planting (1 lb ai/A) 		
June 26	First evaluation			
June 27	Hoed plots without herbicide			
June 30	Second evaluation			
August 1	Harvest			
August 4	2 nd harvest of selected plots			
Soil data	Type	pH	OM	CEC
	silt loam	6.0	7.81	29.6
Plot size/exp. design	10 by 25'	5 replications	RCBD	
Proceeding crop	Vegetables			
Herbicide application data				
Date	6-19-00	6-23-00	6-23-00	6-27-00
Herbicide/treatment	Imazamox	Imazamox Basagran	Imazamox PM	Imazamox
Application timing	1 st trifoliolate	2 nd trifoliolate open	2 nd trifoliolate open	3 rd trifoliolate open o full
Start/end time	9:15-9:45 A	6:30-8 A	4-4:15 P	6:45-7:15 A
Air temp/soil temp (2")/surface	68/78/78	60/70/75	74/85/15	65/68/65
Rel humidity (%)	65	75	40	80
Wind direction/velocity	NE 1-4	0	NE 2-5	0
Cloud cover	10%	haze	0	0
Soil moisture	very dry	dry	very dry	very dry
Plant moisture	dry	heavy dew	very dry	light dew
Sprayer/PSI	BackPack/30	BackPack/30	Back Pack	Back Pack /30
Mix size	2100 ml/ 5 plots	2100 ml/54 plots	2100 ml/ 5 plots	2100 ml/ 5 plots
Gallons H ₂ O/acre	20	20	20	20
Nozzle type	8003	8003	8003	8003
Nozzle spacing and height	20/18	20/18	20/18	20/18

Table 8. Injury and weed control with imazamox at midseason, Independence, 2000

Herbicide	Trifoliolate	Date	Rate	N	19-Jul		26-Jul		Weed control (26-Jul)				Total
					Phyto	Growth reduction	Phyto	Growth reduction	Pigweed	Purslane	Witchgrass	Lambs-quarters	
					0-10	%	0-10	%	----- % -----				
1 Imazamox NIS	Pre1 st	5-Jul	0.016 0.25%	4	1	20	0	6	96	85	84	60	93
2 Imazamox Bentazon NIS	Pre1 st Pre1 st	5-Jul 5-Jul	0.016 0.75 0.25%	4	0	8	0	4	92	93	81	100	93
3 Imazamox NIS	Pre1 st	5-Jul	0.024 0.25%	4	0	33	0	14	95	70	80	75	96
4 Imazamox Bentazon NIS	Pre1 st	5-Jul 5-Jul	0.024 0.75 0.25%	4	0	35	0	24	94	100	71	100	91
5 Imazamox NIS	Pre1 st	12-Jul	0.016 0.25%	4	1	3	0	1	100	95	73	60	90
6 Imazamox Bentazon NIS	1 st tri 1 st tri	12-Jul 12-Jul	0.016 0.75 0.25%	4	0	3	0	3	94	98	63	98	92
7 Imazamox NIS	1 st tri	12-Jul	0.024 0.25%	4	1	10	0	1	100	73	83	79	94
8 Imazamox Bentazon NIS	1 st tri 1 st tri	12-Jul 12-Jul	0.024 0.75 0.25%	4	0	3	0	1	99	100	94	100	96
9 Cobra Imazamox NIS	PES 2 ^{nd+}	18-Jul	0.125 0.024 0.25%	4	-	-	2	4	100	100	93	83	95
10 Dual Imazamox NIS	PES 2 ^{nd+}	18-Jul	1.5 0.024 0.25%	4	-	-	2	3	100	100	100	91	95
11 Eptam Imazamox NIS	PPI 2 ^{nd+}	18-Jul	3.5 0.024 0.25%	4	-	-	2	5	100	86	95	80	93
12 Basagran Poast COC	1 st tri 1 st tri	12-Jul 12-Jul	1 0.47 1%	4	2	6	0	0	58	100	99	100	58
13 Dual Cobra	PES PES		1.5 0.1875	4	0	0	0	1	100	100	99	83	96
14 Poast Imazamox NIS	2 ^{nd+} 2 ^{nd+}	18-Jul 18-Jul	0.23 0.024 0.25%	4	-	-	2	5	-	-	-	-	-
15 Assure Imazamox NIS	2 ^{nd+} 2 ^{nd+}	18-Jul 18-Jul	0.07 0.024 0.25%	4	-	-	1	3	-	-	-	-	-
16 Imazamox Basagran NIS	2 ^{nd+} 2 ^{nd+}	18-Jul 18-Jul	0.032 1 0.25%	4	-	-	1	1	-	-	-	-	-
FPLSD _{0.05}					0.7	7	7	6	6	ns	36	ns	10
CV (%)					179	69	56	93	5	22	21	25	8

Table 9. Effect of imazamox on snap bean yield and weed control, Independence, OR 2000.

Herbicide	Trifoliolate	Rate	Plant population	Plant biomass	Avg. plant wt.	Pod yield	Grade	Weed control				
								Pigweed	Lambs-quarter	Wild proso millet	Witchgrass	Total
		lb ai/A	no/A	t/A	g/plant	T/A	%1-4	----- % -----				
1	Imazamox NIS	1st true 0.016 0.25%	133900	20.1	138	8.3	79	73	55	49	63	58
2	Imazamox Bentazon NIS	1st true 1st true 0.016 0.75 0.25%	121600	21.2	159	9.2	76	80	98	25	50	70
3	Imazamox NIS	1st true 0.024 0.25%	125900	20.7	152	7.6	78	88	71	59	75	79
4	Imazamox Bentazon NIS	1st true 0.024 0.75 0.25%	116900	18.1	143	6.9	85	74	75	58	50	75
5	Imazamox NIS	1st tri 0.016 0.25%	120600	22.0	169	9.8	72	96	76	38	23	84
6	Imazamox Bentazon NIS	1st tri 1st tri 0.016 0.75 0.25%	122200	22.2	165	9.6	77	90	99	70	63	85
7	Imazamox NIS	1st tri 0.024 0.25%	145000	21.9	148	9.7	73	96	83	98	88	90
8	Imazamox Bentazon NIS	1st tri 1st tri 0.024 0.75 0.25%	121600	21.3	162	9.6	75	91	98	98	85	89
9	Cobra Imazamox NIS	PES 2nd ⁺ 0.125 0.024 0.25%	146600	25.1	161	9.9	70	100	91	63	60	89
10	Dual Imazamox NIS	PES 2nd ⁺ 1.5 0.024 0.25%	133300	22.0	150	10.1	80	99	95	99	100	97
11	Eptam Imazamox NIS	PPI 2nd ⁺ 3.5 0.024 0.25%	129100	21.9	157	9.3	83	98	93	98	99	96
12	Basagran Poast COC	1st tri 1st tri 1 0.47 1%	125900	17.1	126	6.8	86	38	100	88	100	50
13	Dual Cobra	PES PES 1.5 0.1875	127000	23.6	169	9.8	78	96	76	38	88	81
16	Imazamox Basagran NIS	2nd ⁺ 2nd ⁺ 0.032 1 0.25%	149300	23.7	147	9.7	75	94	93	83	88	90
LSD _{0.05}			ns	3.2	ns	2.0		16	28	44	44	23
CV (%)			16	10	16	15		13	23	43	41	20

Table 10. Schedule and herbicide application data, Independence, 2000

Activities					
June 21	Planting				
Variety	OR 91G				
Soil data	Type	pH	OM	CEC	
	silt loam	6.2	5.88	28	
Plot size/exp. design	10 by 30'	4 reps	RCBD		
Herbicide application data					
Date	6-21	6-21	7-5	7-12	7-19
Herbicide/treatment	Eptam	Dual, Cobra	Imazamox Basagran	Imazamox Basagran	Imazamox Poast Assure Basagran
Application timing	PPI	PES	POST early 1 st trifoliolate	POST 1 st trifoliolate	POST 2 nd trifoliolate
Start/end time	9:45-10 Am	4:30-5 PM	12-12:30 PM	8-8:30 AM	12-12:30 PM
Air temp/soil temp (2")/surface	77-76-86	80-92-90	77-80-86	68-68-73	75-86-92
Rel humidity	55	42	70	82	52
Wind direction/velocity	0-2.5	N 2-4	NW 1-3	N 0-5.5	0-2 W
Cloud cover	0	0	50	0	0
Soil moisture	very dry	very dry	dry	very dry	damp
Plant moisture	0	0	dry	very dry	dry
Sprayer/PSI	BackPack/30	BackPack/30	Back Pack	Back Pack /30	BP/30
Mix size	2100 ml/ 4 plots	2100 ml/ 4 plots	2100 ml/ 4 plots	2100 ml/ 4 plots	2100 ml/ 4 plots
Gallons H ₂ O/acre	20	20	20	20	20
Nozzle type	8003	8003	8003	8003	8003
Nozzle spacing and height	20/18	20/18	20/18	20/18	20/18
Soil inc. method/implement	Rototiller within 15 min	Inc with irrigation			

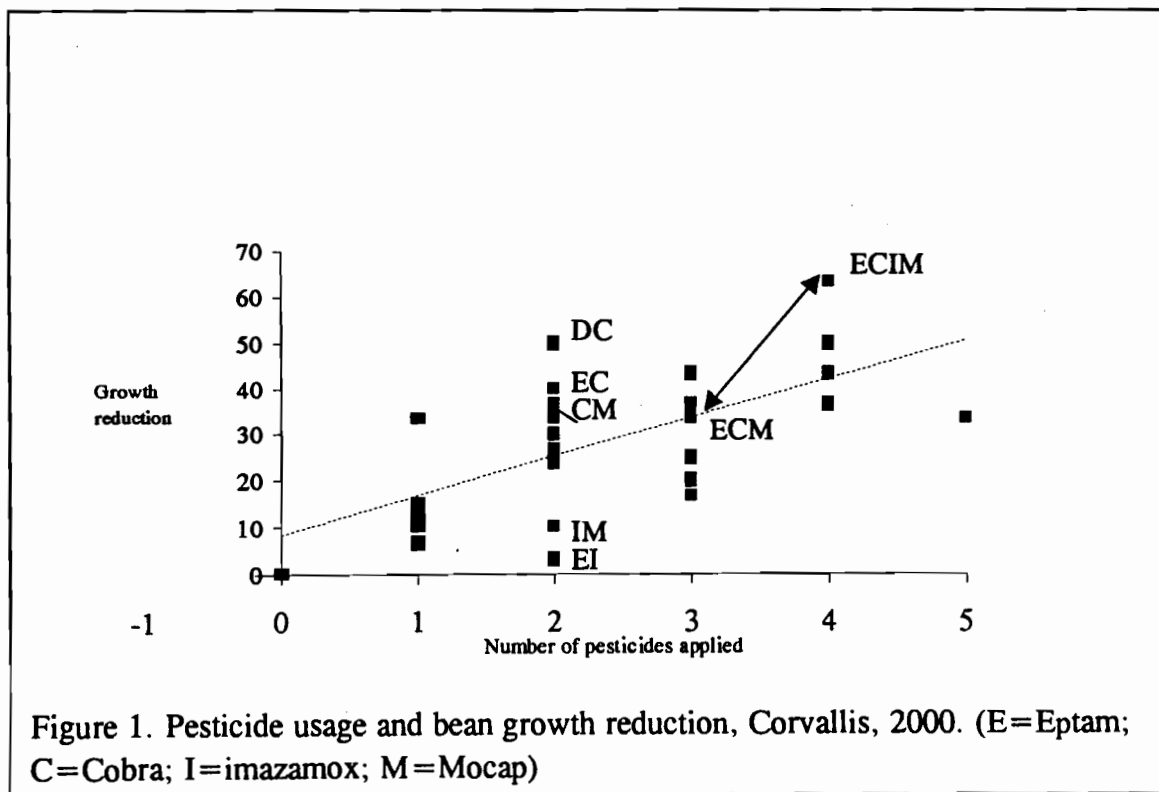
Table 11. Effect of imazamox on weed control, Mt. Angel, 2000

Herbicide	Trifoliolate	Date	Rate	N	Crop Injury				Weed control				
					12-Jul		19-Jul		9-Jul		4-Aug		
					Phyto 0-10	Growth reduction %	Phyto 0-10	Growth reduction %	Pigweed ----- %	Lambs- quarters -----	Pigweed ----- %	Lambs- quarters -----	
1 Imazamox NIS	1 st opening	22-Jun	0.016 0.25 %	4	0.0	0.0	0.0	2.5	100	23	100	0	
2 Imazmox Basagran NIS	1 st opening 1 st opening	22-Jun 22-Jun	0.016 0.75 0.25 %	4	0.0	0.0	0.0	0.0	93	96	83	85	
3 Imazamox NIS	1 st opening	22-Jun	0.024 0.25 %	4	0.0	1.3	0.0	2.5	100	30	100	0	
4 Imazamox NIS	2 nd opening	28-Jun	0.032 0.25 %	4	0.3	8.8	0.0	8.8	96	58	100	45	
5 Imazmox Basagran NIS	2 nd opening	28-Jun	0.032 0.75 0.25 %	4	0.0	1.3	0.0	3.8	95	63	100	38	
Sequential applications													
6 Basagran COC Imazamox NIS	1 st opening 1 st bloom	22-Jun 12-Jul	1 1% 0.032 0.25 %	4	0.0 ^c	0.0 ^a	2.3	8.8	13 ^a	96 ^a	100	93	
7 Basagran COC Imazamox NIS	2 nd opening 1 st bloom	28-Jun 12-Jul	1 1% 0.032 0.25 %	3	0.0 ^a	5.0 ^a	3.0	18.3	8 ^a	53 ^a	100	82	
8 Imazamox Basagran COC	1 st bloom	12-Jul	0.032 1 1%	3	0.0	6.7	0.3	23.3	0.0	0.0	98	28	
FPLSD 0.05					NS		4.5	1.5	11.9	10	24	6	15
CV (%)							120	141	100	10	29	4	22

^c Values on this date only reflect the injury or weed control caused by Basagran.

Table 12. Schedule and herbicide application data, Mt Angel, 2000

Herbicide application data			
Date	June 22	June 28	July 12
Herbicide/treatment	Imazamox, Basagran	Imazamox, Basagran	Imazamox, Basagran
Application timing	1 st tri opening but not fully expanded	2 nd trifoliolate opening	1 st bloom visible
Start/end time	10-10:30 A	10-10:30 A	12:35-12:5 P
Air temp/soil temp (2")/surface	63/80/84	93/105/116	74/89/98
Rel humidity (%)	60	40	60
Wind direction/velocity	N 2 gusting to 5	N 0-4	N 0-3
Cloud cover	0	0	0
Soil moisture	Dry	Dry	Dry
Plant moisture	Dry	Dry	Dry
Sprayer/PSI	BP CO ₂ /30 PSI	BP CO ₂ /30 PSI	BP CO ₂ /30 PSI
Mix size	2100 ml	2100 ml	2100 ml
Gal/A	20	20	20
Nozzle type	8803	8003	8003
Nozzle spacing/height	20 x 18	20 x 18	20 x 18



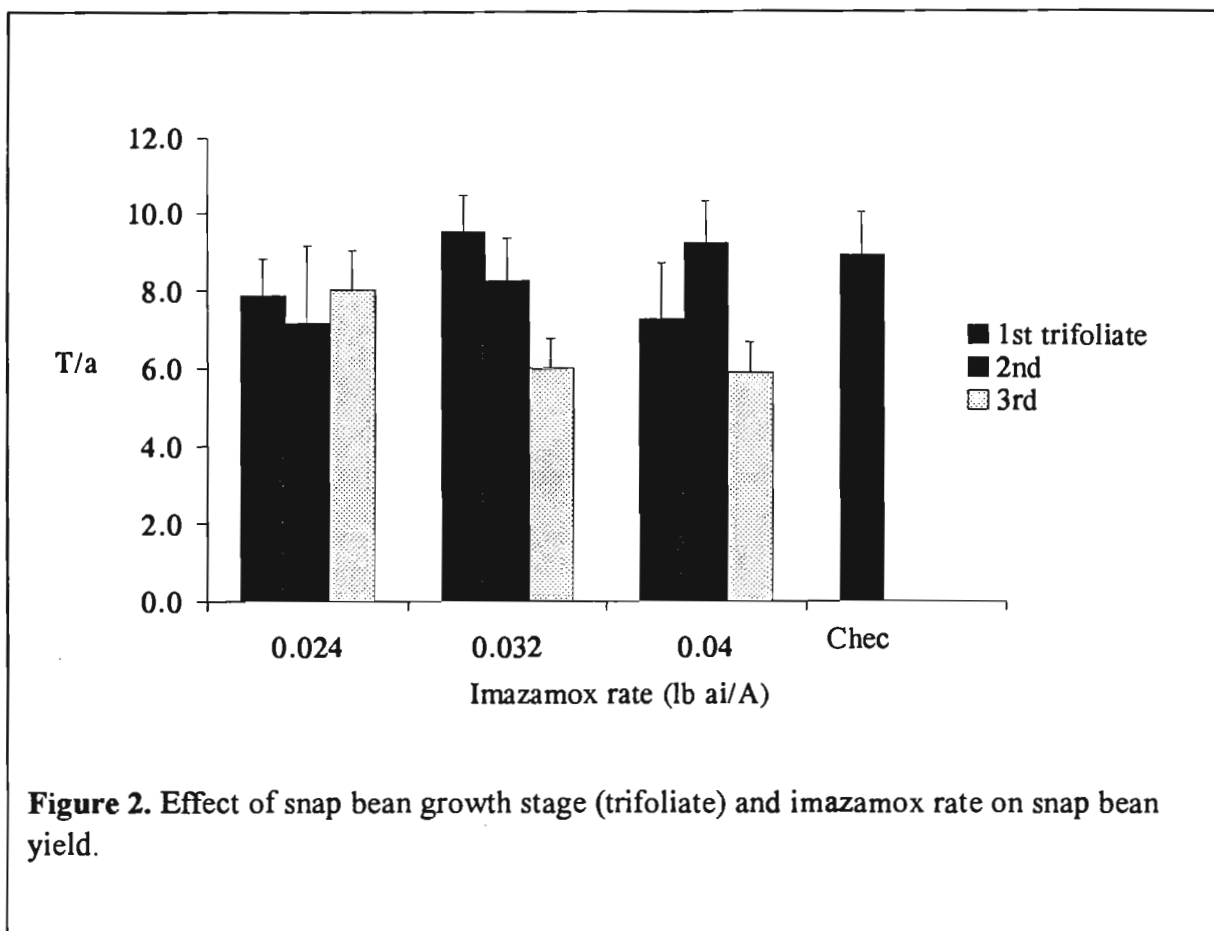


Figure 2. Effect of snap bean growth stage (trifoliolate) and imazamox rate on snap bean yield.

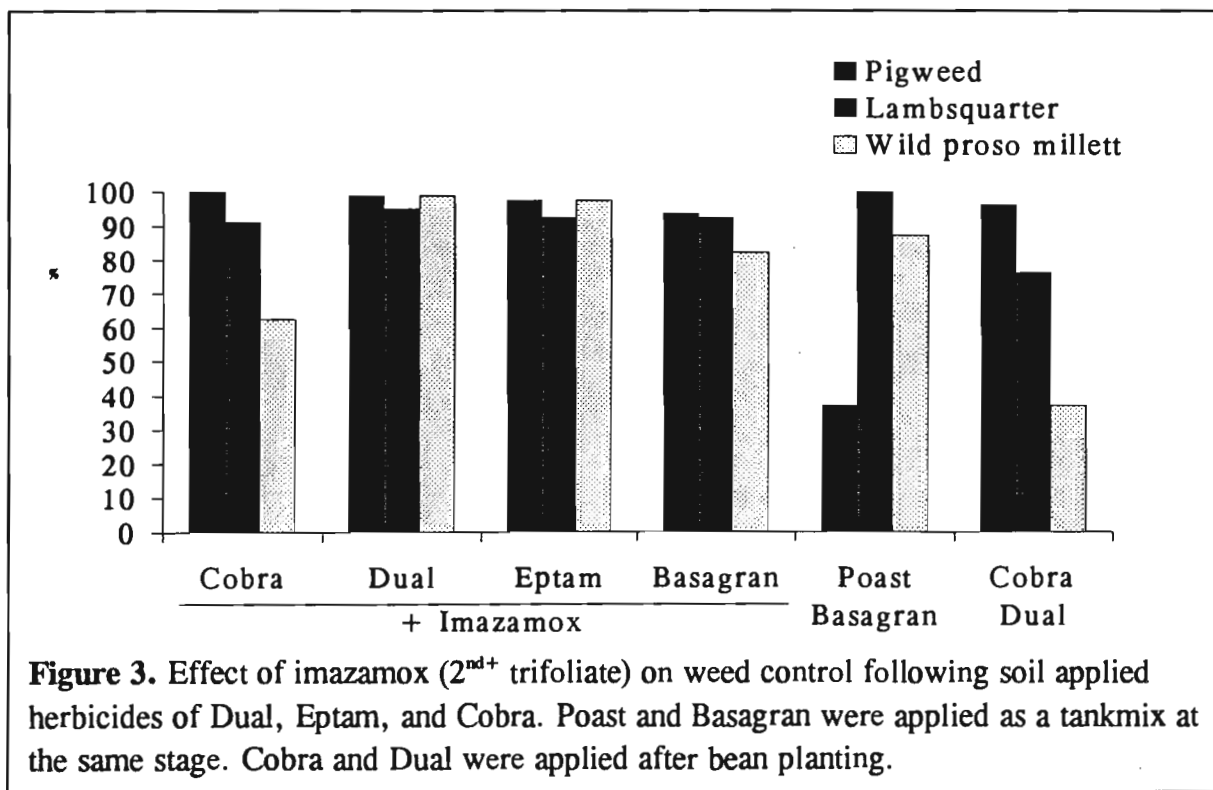


Figure 3. Effect of imazamox (2^{nd+} trifoliolate) on weed control following soil applied herbicides of Dual, Eptam, and Cobra. Poast and Basagran were applied as a tankmix at the same stage. Cobra and Dual were applied after bean planting.