

TITLE: Soil persistence of imazamox herbicide in tilled and direct-seeded dry land, winter wheat cropping systems.

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INTERIM or FINAL REPORT: Interim

PROJECT OBJECTIVES: 1) Determine the response of yellow mustard to imazamox herbicide persistence under conventional, minimum and direct-seed tillage systems in intermediate and high precipitation zones. 2) Determine the dissipation rate of imazamox herbicide under conventional, minimum and direct-seed tillage systems in intermediate and high precipitation zones using a yellow mustard biomass bioassay.

KEY WORDS: Imazamox, soil persistence, tillage, yellow mustard biomass bioassay

STATEMENT OF PROBLEM: Imazamox (Beyond) herbicide, a group 2 acetolactate synthase inhibitor, is used to selectively control weeds, such as jointed goatgrass, downy brome, wild oat and Italian ryegrass, in Clearfield[®] winter wheat. Imazamox can persist in the soil for 3 to 26 months, and thus affect growth of rotational crops such as barley, canola, and mustard. Tillage practices used in dry land winter wheat cropping systems can affect herbicide carryover and injury to rotational crops. However, research is seldom conducted to compare potential herbicide carryover among different tillage practices and environments. Imazamox is used as a model herbicide in this study to determine the effect of an environment by tillage interaction on soil persistence of herbicides used in Pacific Northwest (PNW) dry land winter wheat production systems.

ZONE OF INTEREST: Intermediate and high rainfall, annual cropping

ABSTRACT OF RESEARCH FINDINGS: This study was conducted at the University of Idaho Kambitsch Research Farm near Genesee, Idaho, the Columbia Basin Agricultural Research Center near Pendleton, Oregon, and the Washington State University Wilke Farm near Davenport, Washington to determine the effect of tillage on the persistence of imazamox herbicide. Fall and spring applications of imazamox were applied at one, two, and three times the maximum labeled rate to Clearfield[®] ORCF-101 winter wheat. Soil samples were collected regularly at each site since imazamox was applied in the fall and spring, and were frozen until used in yellow mustard biomass bioassay. Data have been collected on yellow mustard biomass bioassays for all three sites but no statistical analysis has been performed to date. Grain was harvested at all three sites during summer 2006 and tillage strips were implemented in fall 2006. 'IdaGold' yellow mustard was seeded spring 2007 and harvested during summer 2007. This study was repeated in 2006-2008 except soil samples were not collected. Grain was harvested at all three sites during summer 2007 and tillage strips were implemented in fall 2007. 'IdaGold' yellow mustard was seeded during spring 2008 and harvested during summer 2008. At Pendleton, mustard was injured most in the minimum tillage followed by the conventional tillage with the least injury in the direct-seeded plots. At Genesee, mustard was injured most in minimum tillage followed by

conventional, with the least injury in the direct-seed. At Davenport, the conventional and direct-seed had the most injury followed by the minimum with the least injury.

RESULTS AND INTERPRETATION: Procedures: Objective 1: Tillage strips were implemented in fall 2007 at field sites established in August 2006. Moldboard plow, chisel plow, and no-tillage tillage treatments were performed on October 18 at Pendleton and on October 23 at both the Davenport and Genesee sites. ‘IdaGold’ yellow mustard was seeded at 8 lb/A on April 1, 2008 at Pendleton, 10 lb/A on May 2, 2008 at Davenport, and 10 lb/A on May 12, 2008 at Genesee using a Fabro no-till drill with rows spaced 7-inch apart at all three sites. Plant counts were done 21 days after emergence on May 16, 2008 at Pendleton, June 4, 2008 at Davenport and Genesee. Visual injury was evaluated about 56 days after emergence on June 25, 2008 at both Pendleton and Davenport and on July 7, 2008 at Genesee. Aboveground crop biomass samples were collected from two 3.3-ft section of row randomly located within each sub-plot when the control plots reached 50% flowering. Mustard plants were counted, cut at the soil surface, placed in labeled paper bags, dried at 60 C for 72 h, and weighed. This was done on June 6, 2008 at Pendleton, June 19, 2008 at Davenport and on June 26, 2008 at Genesee. Warrior insecticide was applied at 0.03 lb ai/A at Genesee on July 27, 2008 for aphid control. Yellow mustard was harvested at Pendleton on July 31, 2008, at Davenport on September 9, 2008, and at Genesee on August 28, 2008 using a small plot combine.

Objective 2: When field sites were established in August 2005, about 20 kg of soil was collected at each site. The soil was used in the laboratory to develop standard dose response curves relating yellow mustard plant biomass to imazamox concentration in soil for each field test site. Preliminary bioassays were conducted a minimum of three times for each site. Stock herbicide suspensions were prepared by mixing 64 mg ai of imazamox into 1,000 ml of distilled water. The appropriate volume of the stock solution was pipetted into the appropriate amount of distilled water for a total volume of 15 ml and applied with an atomizer to 500 g of air-dried soil in a 33-by 40-cm plastic bag to achieve final herbicide concentrations of 0, 0.5, 1, 2, 4, 8, 16, 32, and 64 ng ai/g. The estimated concentration of imazamox in the top 20 cm of soil (approximated to weigh 2.86 million kg/ha) immediately after herbicide application was 18.5, 37, and 55.5 ng/g for the 53 (1X), 106 (2X), and 159 (3X) g ai/ha rates, respectively. Treated soil was mixed by shaking the soil in the bag for 2 minutes and allowed to air-dry for 4 hr. Six plastic ‘conetainers’ (3.8 cm diam by 14 cm deep) had a jumbo cotton ball placed in the bottom to prevent the soil from falling out and were filled with 80 g of treated soil to within 0.6 cm of the top. Three germinated ‘IdaGold’ yellow mustard seeds were placed on the soil in each tube and covered with a thin layer of potting soil. Plants in each ‘conetainer’ were thinned to 1 plant immediately after emergence. ‘Conetainers’ were placed in racks and incubated in a growth chamber at 21 C with a 16-h photoperiod for 14 days. A plastic container was placed under a group of 6 ‘conetainers’ by treatment and filled with distilled water for sub-irrigation throughout the duration of the bioassay tests. Treatments were arranged in a randomized complete block design with six replications. Yellow mustard biomass was collected 14 DAT and biomass was dried at 60 C for 48 hr and weighed. The response of plant height and biomass to imazamox concentration was calculated as a fraction of the untreated control treatment and fitted to the standard curve model

$$Y = B_0 - B_1(\ln(\text{Dose} + 1)),$$

where Y is plant biomass as a fraction of the control, B_0 is the response at dose = 0, B_1 is the rate of response as dose increases, and dose is the herbicide concentration (ng/g). The equation is an exponentially decreasing curve where percent plant biomass decreases as dose increases.

Discussion of results:

Yellow mustard data are expressed as a percentage of the untreated control. Data are presented by location and separated by treatment and tillage for both the Davenport and Genesee sites because there was no significant treatment by tillage interactions. There was a significant treatment by tillage interaction for the Pendleton site (Table 1).

At Pendleton and Genesee, seed yield was reduced the least by the 1X fall and spring rates of imazamox compared to other treatments (Table 2). At Davenport, the 1X imazamox rate applied in the fall had significantly higher mustard yield than all other treatments.

At Pendleton and Genesee, mustard injury was the same among tillage treatments, while at Davenport, injury was least in the minimum tillage (Table 3). At all three locations, yield was not significantly different among tillage treatments. Seed yield was not different between fall and spring applied imazamox treatments at Pendleton and Genesee (Tables 4 and 5). At Davenport seed yield was less with spring applied imazamox compared to the fall application. Injury was always greater for the 2X versus the 1X application rate at all locations. There always was significantly less injury, and more biomass and seed yield at the 1X application rate compared to the 2X and 3X at both Pendleton and Genesee but only for injury and yield at Davenport.

Data has been collected on yellow mustard biomass bioassays for all three sites but no statistical analysis has been performed.

Visit the STEEP website for results from previous years:

http://pnwsteep.wsu.edu/annualreports/2006/pdf/Thill_Soil_Persist.pdf

http://pnwsteep.wsu.edu/annualreports/2007/pdf/Thill_Soil_persistence.pdf

IMPACTS OF RESEARCH: This study will serve as a model to determine the effect of an environment by tillage interaction on soil persistence of herbicides used in PNW dryland winter wheat production systems. More specifically, this research will determine which tillage system is best suited to reduce the amount of herbicide carryover injury to crops grown in rotation with Clearfield[®] winter wheat. This in turn will benefit farmers who choose to have Clearfield[®] winter wheat in their crop rotations.

INTERACTION (COOPERATION) WITH OTHER SCIENTISTS CONDUCTING RELATED ACTIVITY: Consulted with Aaron Esser (WSU) on establishing sites for both years and about equipment that is available for use at Wilke Farm near Davenport. Also consulted with Larry Bennett and Dan Ball (OSU) regarding the Columbia Basin Agricultural Research Center site, Rod Rood, John Nelson, and Joe Yenish (WSU) regarding the Wilke farm site, and Roy Patten, Brad Bull, and Dave Hoadley (UI) regarding the Genesee farm site.

PUBLICATIONS AND PRESENTATIONS:

Rood, J.R., D. Thill D. Ball, and J. Yenish. 2008. Tillage affects imazamox carryover in yellow mustard. Western Society of Weed Science Meeting, Anaheim, CA, March 11.

Rood, J.R. 2008. Tillage affects imazamox carryover in yellow mustard. WSU Wilke Farm Field Day, June 25.

Rood, J.R. 2008. Tillage affects imazamox carryover in yellow mustard. University of Idaho Weed Science Field Day, June 12.

Table 1: 2008 interactions for Pendleton injury, biomass and yield.

		Tillage Treatment			
Imazamox		Conventional	Minimum	Direct-Seed	<i>Means¹</i>
g ai/ha	Timing	-----Injury (%)-----			
53	Fall	50	35	31	<i>39d</i>
105	Fall	81	65	45	<i>64c</i>
157	Fall	92	71	56	<i>73b</i>
53	Spring	38	46	51	<i>45d</i>
105	Spring	44	80	81	<i>68bc</i>
157	Spring	70	84	93	<i>82a</i>
		<i>62a</i>	<i>64a</i>	<i>60a</i>	

g ai/ha	Timing	-----Biomass(%)-----			
53	Fall	12	40	78	<i>44a</i>
105	Fall	2	34	62	<i>33ab</i>
157	Fall	1	24	42	<i>22bc</i>
53	Spring	31	18	22	<i>24b</i>
105	Spring	13	2	6	<i>7c</i>
157	Spring	8	9	2	<i>7c</i>
		<i>11b</i>	<i>21ab</i>	<i>35a</i>	

g ai/ha	Timing	-----Yield (%)-----			
53	Fall	43	48	79	<i>57a</i>
105	Fall	8	12	26	<i>15b</i>
157	Fall	5	18	8	<i>10b</i>
53	Spring	68	39	45	<i>50a</i>
105	Spring	40	9	5	<i>18b</i>
157	Spring	8	11	1	<i>7b</i>
		<i>29a</i>	<i>23a</i>	<i>27a</i>	

Table 2: 2008 mustard injury, biomass, and yield by application timing and rate as a percentage of the untreated control.

Treatment	Rate	Application timing	Pendleton			Genesee			Davenport		
			Injury	Biomass	Yield	Injury	Biomass	Yield	Injury	Biomass	Yield
	lb ai/A		%	%	%	%	%	%	%	%	%
Imazamox	0.047	Fall	39	44	57	48	68	66	48	38	69
Imazamox	0.094	Fall	64	33	15	64	45	36	80	57	15
Imazamox	0.140	Fall	73	22	10	79	25	19	89	12	11
Imazamox	0.047	Spring	45	24	50	50	43	51	81	34	25
Imazamox	0.094	Spring	68	7	18	71	29	26	95	8	6
Imazamox	0.140	Spring	82	7	7	81	32	14	98	1	0
LSD (0.05)			9	16	12	12	21	24	8	NS	15

Table 3: 2008 mustard injury, biomass, and yield by tillage as a percentage of the untreated control.

Tillage	Pendleton			Genesee			Davenport		
	Injury	Biomass	Yield	Injury	Biomass	Yield	Injury	Biomass	Yield
	%	%	%	%	%	%	%	%	%
Conventional	62	11	29	67	38	28	84	6	15
Minimum	64	21	23	70	29	30	79	15	23
Direct-seed	60	35	27	59	55	50	83	54	26
LSD (0.05)			NS	NS	NS	NS	4	NS	NS

DF=1

Table 4: 2008 mustard injury, biomass, and yield contrasts.

Contrasts	Pendleton			Genesee			Davenport		
	Injury	Biomass	Yield	Injury	Biomass	Yield	Injury	Biomass	Yield
	%	%	%	%	%	%	%	%	%
-----P-Values-----									
Fall vs. Spring	0.0092	<.0001	0.5095	0.6046	0.0246	0.2840	<.0001	0.1298	<.0001
1X vs. 2X	<.0001	0.0171	<.0001	<.0001	0.0057	0.0014	<.0001	0.8449	<.0001
1X vs. 2&3X	<.0001	0.0013	<.0001	<.0001	0.0006	<.0001	<.0001	0.2790	<.0001

Table 5: 2008 mustard injury, biomass, and yield contrast means.

	Fall vs. Spring ¹			1X vs. 2X ²			1X vs. 2&3X ³		
	Injury	Biomass	Yield	Injury	Biomass	Yield	Injury	Biomass	Yield
	%	%	%	%	%	%	%	%	%
Pendleton	59/65	33/12	27/25	42/66	34/20	54/17	42/72	34/17	54/13
Genesee	62/64	49/34	41/33	46/66	58/36	61/32	46/72	58/34	61/26
Davenport	72/91	36/14	32/10	64/87	36/33	47/11	64/90	36/20	47/8

¹Numbers to the left of the slash represent means for fall while numbers to the right of the slash represent means for spring.

²Numbers to the left of the slash represent means for 1X while numbers to the right of the slash represent means for 2X.

³Numbers to the left of the slash represent means for 1X while numbers to the right of the slash represent means for 2&3X.