Title: Evaluating chemical fallow systems for weed control efficacy

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Interim Report:

Specific objectives:
1) Determine weed control efficacy of chemical-fallow treatments
2) Determine comparative wheat injury chemical-fallow.

Keywords: Chemical fallow, Russian thistle, mayweed chamomile

Statement of problem: Chemical fallow as practiced in the Pacific Northwest depends heavily on repeated applications of glyphosate. Russian thistle and other broadleaf weeds often establish despite repeated postemergence herbicide application. More effective chemical fallow programs must be established to make the system more efficient and to prevent the development of glyphosate-resistant weeds.

Agronomic zone of interest: Low, intermediate, and high rainfall zones

Production systems being investigated: Winter wheat – chemical fallow

Abstract of Research Findings: Research was conducted near Lind and Pullman, WA in the low and high rainfall production zones, respectively, to determine the efficacy of various herbicides in a chemical fallow system. Predominant species at Lind and Pullman were Russian thistle and mayweed chamomile, respectively. Weed density and biomass were measure on July 15 and August 4 at the same respective locations. At Lind, broadleaf weed populations and biomass tended to be greatest with glyphosate regardless of number or timing of applications. The lowest weed density and biomass were with 0.064 lbs. isoxaflutole plus 0.141 lbs. sulfentrazone/acre applied March 10 followed by 0.375 lbs glyphosate/acre applied April 12. Isoxaflutole plus sulfentrazone reduced broadleaf density and biomass 97 and 91%, respectively, greater than glyphosate applications. Treatments with weed density or biomass that not greater than isoxaflutole plus sulfentrazone included 0.188 and 0.141 lbs sulfentrazone/acre, 0.064 lbs flumioxazin/acre, 0.080 lbs isoxaflutole/acre, and 0.064 lbs flumioxazin plus 0.141 lbs sulfentrazone/acre. None of the treatments containing dicamba, metribuzin, or paraquat plus diuron differed from glyphosate treatments for weed density or biomass. At Pullman, greatest weed density and biomass tended to be with glyphosate only treatments applied April 28 or earlier. However, an additional glyphosate application made June 22 reduced plant density and biomass 97 and 100%, respectively, than earlier glyphosate applications. Tankmix combination of 0.064 lbs flumioxazin plus 0.141 lbs sulfentrazone/acre and 0.064 lbs isoxaflutole plus 0.141

lbs sulfentrazone/acre and sequential applications of 0.5 lbs paraquat plus 0.25 lbs diuron/acre also reduced weed density and biomass 90% or better compared to early applied glyphosate. The efficacy of treatments varied between locations due to different weed species. While glyphosate remains a critical component of chemical fallow systems, it is possible to achieve good weed control with fewer glyphosate applications when combined with residual herbicides.

Results and Interpretations:

Procedures:
Objective 1: Field sites were identified and established in the fall of 2003 on the Rob Dewald Farm near the WSU Dryland Research Station at Lind (low rainfall) and on the Sheryl and Eric Zakarison Farm near the USDA-ARS Palouse Conservation Field Station (high rainfall). The same 21 treatments were initially included in the design for both locations. Treatments included combinations of glyphosate across three timings and glyphosate tankmixed or in sequence with residual herbicides. An additional treatment was to apply glyphosate as needed at the discretion of the principal investigator. It was assumed that glyphosate would effectively control grasses. Sulfentrazone, flumioxazin, and isoxaflutole were expected to provide residual control only and were applied without glyphosate on March 10 and March 30, 2004 at Lind and Pullman, respectively. Dicamba and metribuzin were expected to provide foliar and residual control were tankmixed with glyphosate on April 12 and April 28, 2004 at the same respective locations. Weed density and biomass were measure on July 15 and August 4 at the same respective locations. All weeds in each plot were counted, clipped at the soil surface, weighed, oven-dried for 48 hrs, and weighed again. Thus, the weed parameters measured and analyzed included, number of plants per plot, fresh weight per plot, and dry weight per plot. Only broadleaf weeds were present as grass weeds were eliminated by glyphosate or parquet plus diuron at both locations. At Lind, Russian thistle was more than 80% of the total plant population and biomass while at Pullman mayweed chamomile was nearly 50% of the same parameters. Statistical analysis of data was performed on a log + 1 transformation of each data point because treatment variances of raw data were determined to be not homogenous. A fall glyphosate application of glyphosate was made across the entire plot site at the high rainfall location due to a high population of grass weeds. This effectively created two treatments of sequential applications of fall and late spring glyphosate. The originally designed fall and late spring glyphosate treatment was dropped from the data analysis.

Objective 2. Corners of experimental area were marked for relocation. Cooperating farmers will plant winter wheat in the fall of 2004. Plots will be remarked after crop establishment and stand counts or other evaluation taken.

Discussion: Weed density and biomass were typically greatest with glyphosate applications made in April only or in sequence with applications made in December or March at both locations. However, the June glyphosate application was extremely effective in reducing weed numbers and biomass at Pullman (Table 1) while that application at Lind (Table 2) had no effect compared to earlier glyphosate applications. All other glyphosate only applications regardless of timing had the greatest or not different than the greatest weed population and biomass at both locations. The dramatic difference is likely due to greater efficacy of glyphosate on the primary species at Pullman (mayweed chamomile) than on the primary species at Lind (Russian thistle). The same dramatic difference was noted with the paraquat plus diuron applied in sequence.

The most effective and consistent control of weeds across locations was with combinations of isoxaflutole plus sulfentrazone and flumioxazin plus sulfentrazone. These treatments had the lowest or not less than the lowest weed density and biomass at both the Russian thistle infested site at Lind and the mayweed chamomile infested site at Pullman. Sulfentrazone, isoxaflutole, and flumioxazin tended to provide better weed control than dicamba and metribuzin at both locations. However, the differences were not great and were inconsistent across the study locations. Paraquat plus diuron better control of weeds at both locations applied along or in sequence, but the sequential applications did provide better control than a sole application in April.

The costs of the various treatments are listed in Table 3. The difference between the highest and lowest cost treatments is $ 23.50/A. However, this also roughly represents the difference between the least and most effective weed control treatments. A precise cost/return comparison can't be made at this time because impact of the various treatments on the following crop of wheat has not yet been evaluated. However, the price difference wouldn't appear to make the most effective treatment unappealing.

In summary, glyphosate applications may have been more effective if application timings were different. However, in this study the same or better broadleaf weed control was achieved with residual applications of flumioxazin or isoxaflutole plus sulfentrazone. Thus, it is possible to control weeds in chemical fallow with only a single glyphosate application if applied in combination with a residual material.

Table 1. Weed density, fresh weight, and dry weight at Pullman, WA August 1, 2004.

Treatment	Rate	Application Date	Total Weed					
			Density		Fresh Weight		Dry Weight	
			Plants/A		Lbs/A		Lbs/A	
Glyphosate	0.375	04/28/04	4870	a	840	ab	200	ab
Glyphosate; glyphosate	0.375; 0.375	03/30/04; 04/28/04	6450	ab	1360	ab	380	ab
Glyphosate; glyphosate; glyphosate	0.375; 0.375; 0.375	03/30/04; 04/28/04; 06/22/04	110	h	0	g	0	f
Sulfentrazone; glyphosate	0.188; 0.375	03/30/04; 04/28/04	1580	b-f	300	a-d	70	abc
Sulfentrazone; glyphosate	0.141; 0.375	03/30/04; 04/28/04	3940	a-e	980	abc	320	abc
Flumioxazin; glyphosate	0.080; 0.375	03/30/04; 04/28/04	1150	d-h	150	c-f	40	c-f
Flumioxazin; glyphosate	0.064; 0.375	03/30/04; 04/28/04	2900	b-g	940	b-f	300	b-e
Isoxaflutole; glyphosate	0.080; 0.375	03/30/04; 04/28/04	1540	c-h	180	b-f	50	b-e
Isoxaflutole; glyphosate	0.064; 0.375	03/30/04; 04/28/04	2260	a-e	180	a-e	50	b-e
Flumioxazin; sulfentrazone; glyphosate	0.064; 0.141; 0.375	03/30/04; 03/30/04; 04/28/04	570	e-h	30	d-g	10	def
Isoxaflutole; sulfentrazone; glyphosate	0.064; 0.141; 0.375	03/30/04; 03/30/04; 04/28/04	250	fgh	30	efg	10	def
Dicamba; glyphosate	0.5; 0.375	04/28/04; 04/28/04	3150	ab	550	ab	130	ab
Dicamba; glyphosate	0.375; 0.375	04/28/04; 04/28/04	3940	ab	430	abc	110	ab
Dicamba; glyphosate	0.25; 0.375	04/28/04; 04/28/04	3330	abc	490	abc	130	abc
Dicamba; glyphosate	0.125; 0.375	04/28/04; 04/28/04	2110	a-d	450	abc	120	abc
Metribuzin; glyphosate	0.5; 0.375	04/28/04; 04/28/04	570	c-h	490	a-d	40	bcd
Metribuzin; glyphosate	0.375; 0.375	04/28/04; 04/28/04	1110	b-g	350	abc	100	abc
Metribuzin; glyphosate	0.25; 0.375	04/28/04; 04/28/04	3190	abc	1070	a	340	a
Paraquat + diuron	0.5 + 0.25	04/28/04	900	c-h	220	a-e	70	b-e
Paraquat + diuron; Paraquat + diuron	0.5 + 0.25; 0.5 + 0.25	03/30/04; 04/28/04	250	gh	60	fg	20	ef

Means followed by the same letter do not significantly differ (p=0.05 LSD) for Log + 1 transformed data. Data shown are not transformed.

Table 2. Weed density, fresh weight, and dry weight at Lind, WA July 15, 2004.

Treatment	Rate	Application Date	Total Weed Density		Total Weed Fresh Weight		Total Weed Dry Weight	
			Plants/A		Lbs/A		Lbs/A	
Glyphosate	0.375	04/12/04	2,580	abc	970	ab	260	ab
Glyphosate; glyphosate	0.375; 0.375	12/15/03; 04/12/04	2,900	abc	1,810	ab	610	ab
Glyphosate; glyphosate	0.375; 0.375	03/10/04; 04/12/04	3,510	ab	880	ab	230	ab
Glyphosate; glyphosate; glyphosate	0.375; 0.375; 0.375	03/10/04; 04/12/04; 06/23/04	2,790	a-d	580	ab	180	ab
Sulfentrazone; glyphosate	0.188; 0.375	03/10/04; 04/12/04	390	gh	120	d	50	cd
Sulfentrazone; glyphosate	0.141; 0.375	03/10/04; 04/12/04	320	fgh	180	bcd	40	bcd
Flumioxazin; glyphosate	0.080; 0.375	03/10/04; 04/12/04	820	d-g	370	ab	100	abc
Flumioxazin; glyphosate	0.064; 0.375	03/10/04; 04/12/04	790	d-g	320	a-d	130	a-d
Isoxaflutole; glyphosate	0.080; 0.375	03/10/04; 04/12/04	750	d-g	310	abc	120	a-d
Isoxaflutole; glyphosate	0.064; 0.375	03/10/04; 04/12/04	2,440	a-d	1,150	ab	450	a
Flumioxazin; sulfentrazone; glyphosate	0.064; 0.141; 0.375	03/10/04; 03/10/04; 04/12/04	390	e-h	60	cd	10	d
Isoxaflutole; sulfentrazone; glyphosate	0.064; 0.141; 0.375	03/10/04; 03/10/04; 04/12/04	70	h	50	d	10	cd
Dicamba; glyphosate	0.5; 0.375	04/12/04; 04/12/04	720	d-g	570	ab	200	ab
Dicamba; glyphosate	0.375; 0.375	04/12/04; 04/12/04	1,400	a-d	330	ab	110	ab
Dicamba; glyphosate	0.25; 0.375	04/12/04; 04/12/04	2,080	cde	640	a-d	130	a-d
Dicamba; glyphosate	0.125; 0.375	04/12/04; 04/12/04	1,720	a-d	720	ab	160	ab
Metribuzin; glyphosate	0.5; 0.375	04/12/04; 04/12/04	1,470	b-e	580	abc	150	abc
Metribuzin; glyphosate	0.375; 0.375	04/12/04; 04/12/04	1,790	a-d	630	ab	260	ab
Metribuzin; glyphosate	0.25; 0.375	04/12/04; 04/12/04	3,900	a	1,880	a	450	a
Paraquat + diuron	0.5 + 0.25	04/12/04	1,040	c-g	550	ab	120	ab
Paraquat + diuron; Paraquat + diuron	0.5 + 0.25; 0.5 + 0.25	03/10/04; 04/12/04	1,360	c-f	660	ab	130	ab

Means followed by the same letter do not significantly differ (p=0.05 LSD) for Log + 1 transformed data. Data shown are not transformed.

Table 3. Cost of applications at Lind and Pullman, WA. Provided by North Dakota State University 2004 Weed Control Guide (http://www.ag.ndsu.nodak.edu/weeds/w253/w253w.htm).

Treatment	Rate	Lind	Pullman
Glyphosate	0.375	$ 7.91	15.82
Glyphosate; glyphosate	0.375; 0.375	$ 15.83	23.74
Glyphosate; glyphosate; glyphosate	0.375; 0.375; 0.375	$ 23.74	31.65
Sulfentrazone; glyphosate	0.188; 0.375	$ 20.91	28.82
Sulfentrazone; glyphosate	0.141; 0.375	$ 18.41	26.32
Flumioxazin; glyphosate	0.080; 0.375	$ 20.31	28.22
Flumioxazin; glyphosate	0.064; 0.375	$ 18.41	26.32
Isoxaflutole; glyphosate	0.080; 0.375	$ 27.55	35.46
Isoxaflutole; glyphosate	0.064; 0.375	$ 23.91	31.82
Flumioxazin; sulfentrazone; glyphosate	0.064; 0.141; 0.375	$ 25.91	33.82
Isoxaflutole; sulfentrazone; glyphosate	0.064; 0.141; 0.375	$ 31.41	39.32
Dicamba; glyphosate	0.5; 0.375	$ 19.16	27.07
Dicamba; glyphosate	0.375; 0.375	$ 16.31	24.22
Dicamba; glyphosate	0.25; 0.375	$ 13.51	21.42
Dicamba; glyphosate	0.125; 0.375	$ 10.71	18.62
Metribuzin; glyphosate	0.5; 0.375	$ 21.01	28.92
Metribuzin; glyphosate	0.375; 0.375	$ 17.71	25.62
Metribuzin; glyphosate	0.25; 0.375	$ 14.46	22.37
Paraquat + diuron	0.5 + 0.25	$ 9.91	17.82
Paraquat + diuron; Paraquat + diuron	0.5 + 0.25; 0.5 + 0.25	$ 19.82	27.73

Cost figures include $3.00/A per application timing and cost of recommended adjuvants. Pullman costs reflect the added cost of a fall application of 0.375 lbs. glyphosate/A with 8.5 lbs ammonium sulfate per 100 gallons spray solution applied at 10 gallons of solution/A. Costs are intended to serve as a comparison, actual grower costs may vary.

Cooperation with Other Scientists Conducting Related Activity: Consulted with Dennis Tonks and Aaron Esser in establishing experiments and other experiments not reported here. We have discussed expanded future chemical fallow project with Dan Ball and Donn Thill with experimental objectives and design based heavily on results of this and other studies.

Publications and Presentation: Related experiment were shown and a general discussion presented at the Wilke Farm Tour, Davenport, WA in July 2004.