

Triasulfuron and Chlorsulfuron Persistence Under Zero and Minimum Tillage

H.A.Loeppky and D.A.Derksen
Agriculture Canada
Melfort and Indian Head Saskatchewan

Introduction

Reducing or eliminating tillage can preserve soil quality and reduce soil loss through wind and water erosion. Research conducted in the thin black and black soil zones of Saskatchewan indicates that direct seeding of cereals, oilseeds and pulses is not only possible but economically viable. However, there are still many unanswered questions on the impact of reducing tillage on production related factors such as weed populations and weed management, weed interference and herbicide effectiveness and persistence.

Chlorsulfuron and triasulfuron are sulfonylurea herbicides which will control broadleaved weeds in cereals at very low rates (10-25 g/ha) of application. Even at these very low rates, residues of these herbicides can inhibit the growth of rotational crops. Chlorsulfuron has recently been removed from the market because of its persistence in the soil. Triasulfuron (CGA-131036) is a new sulfonylurea herbicide being developed by Ciba Geigy Canada Ltd that provides both pre and post emergent control of a broad spectrum of weeds in cereal crops. Similar to chlorsulfuron, it has been found to affect the growth of sensitive crops for months to years after application. These herbicides are most available and hence most toxic when organic matter content is low, soil pH is high and drought or poor drainage prevents leaching. Smith and Hsiao (1985) found 3-16% of ¹⁴C-chlorsulfuron remaining in the top 10 cm of the soil 1 year after application to Regina heavy clay with a pH of 7.7 and organic matter content of 4.2%, when conditions were somewhat dry. Moyer and his coworkers (1989) reported that alfalfa and lentils were sensitive to chlorsulfuron concentrations as low as 0.01 ng/g of soil. This was the amount of chlorsulfuron remaining 4 years after a 25 g/ha application. The persistence of other residual herbicides has been found to differ with tillage practices (Ferris et al, 1989 Sorenson et al, 1991) but to date, no information has been published on the influence of tillage on the persistence of triasulfuron and chlorsulfuron.

The objectives of this research were to determine the persistence of these two herbicides under reduced tillage practices.

Materials and Methods

Field experiments were conducted from 1988 to 1991 on a thin black chernozemic Indian Head clay (72% clay, 24% silt, 4% sand and 3% organic matter) and a pH of 8.0. Two separate experiments were conducted. One was located in a field that had been direct seeded without tillage for a period of five years and this trial was not tilled during the course of the experiment. The other experiment was located in a summerfallow field and was tilled once each fall during the course of the experiment. Wheat was planted in April 29, 1988 and herbicides were applied on May 26, 1988 in 110 L/ha of water with a CO₂ backpack sprayer at 275 kPa pressure. Triasulfuron was applied at 5.5, 8, 11 and 22 g/ha and chlorsulfuron was applied at 11 and 22 g/ha. The

design was a modified randomized complete block design with crops rotating from canola to lentils to barley in the three years after the herbicides were applied. Weeds were counted early in June after which herbicides were applied to them. Crop stand, dry matter (1990 and 1991 only), yield, 1000 seed weight and bushel weight were determined each year. An ANOVA was performed on the data and contrasts were done to compare the herbicide treated plots to the untreated, and to test for linear, quadratic and cubic relationships between triasulfuron or chlorsulfuron rate and crop yield. The weather was very hot and dry in June, 1988 with 65% of normal precipitation coupled with an average temperature of 6°C above normal. Dry conditions prevailed until June, 1989 after which precipitation increased to slightly above normal in 1990 and 1991.

Results and Discussion

Barley was generally not sensitive to either of the herbicides in either tillage system and no significant reductions in plant population, plant dry weight (data not presented) or yield (figures 1, 2 and 3) resulted from the application of either herbicide at any of the rates tested in either tillage system. Barley metabolizes chlorsulfuron rapidly and tends to be tolerant to sulfonylurea herbicides (Foley, 1985). In the spring of 1989, soil moisture was very low as a result of below normal precipitation from freeze up until mid-May. In mid-May, when the crop was in the 2-4 leaf stage, a severe wind storm resulted in extensive crop damage in the tilled plots. Consequently, barley yields in these plots was extremely variable (fig. 1).

Weed germination was late that year also and maintenance herbicides were not applied in some cases due to the advanced stage of the crop. As a result, yield benefits were realized in the untilled plots due to weed control from herbicide residues but, in the tilled plots weed control was poor in all plots indicating that herbicide residues were not active. Weed counts were done early in June before the majority of the weeds germinated in 1989, hence weed counts did not reflect the true level of weed competition. Counts done in 1990 (fig. 4 and 5) reflect the contribution made to the seed bank in 1989 and also show that weeds which one might expect to be controlled by residues of the two herbicides (stinkweed,flixweed and redroot pigweed) were not controlled in the tilled plots but were controlled in the untilled plots. This is further evidence that residues were more persistent in the untilled plots.

Canola yield was highly variable due to establishment problems due to climate and seeding equipment. Significant yield reductions of canola were recorded in 1989 only, however, this may be due to the high degree of variability (data not presented here).

Lentils, on the other hand are very sensitive to sulfonylurea herbicide residues (Moyer et al, 1989, Friesen and Wall, 1991), and significant yield reductions were observed in response to herbicide treatments. 1989 was dry, with high winds and as a result, the lentil crop was variable and poor but in 1990 and 1991 much more consistent results were observed. While plant populations did not differ significantly between treatment in any of the three years of the study (data not presented), plant dry weight and yield were significantly reduced by increasing rates of triasulfuron in untilled plots in 1989, both tillage systems in 1990 and untilled plots in 1991 (fig. 6-8). Lines were fit to the data only where contrasts indicated that the linear relationship was significant and quadratic or cubic were not. Although the fit was quite good in some cases, fitting a straight line does not reflect the fact that one would expect a slower rate of response or more gentle slope at very low and very high doses (Gunter et al, 1989).

Figure 1. 1989 barley response to triasulfuron applied in 1988

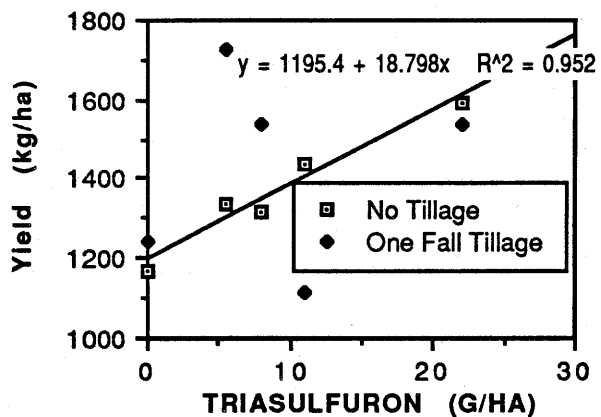


Figure 2. 1990 barley response to triasulfuron applied in 1988

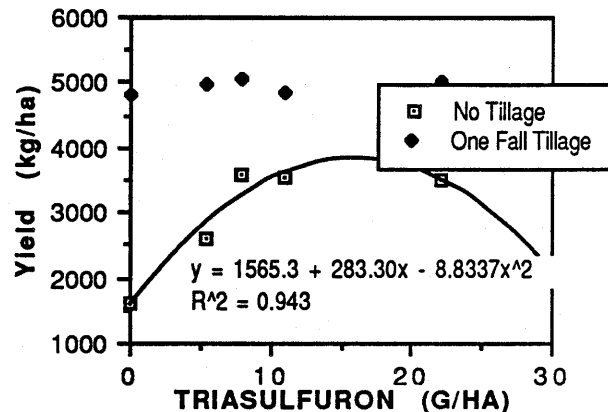


Figure 3. 1991 barley response to triasulfuron applied in 1988

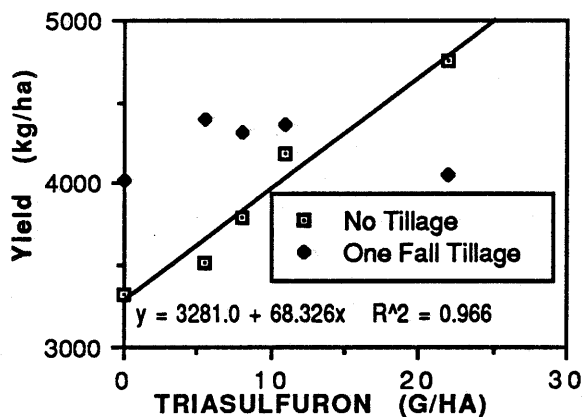


Figure 5. Weed population in untilled barley plots June 1990. Figure 4. Weed population in tilled barley plots June, 1990

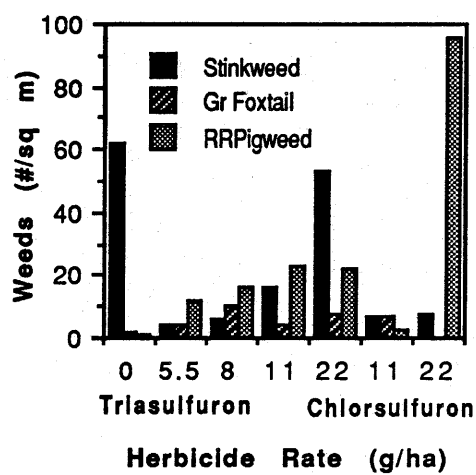
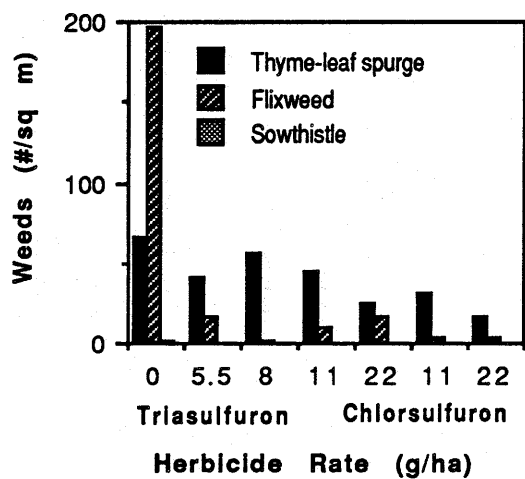


Figure 6. 1989 lentil yield response to triasulfuron applied in 1988. Figure 7. 1990 lentil yield response to triasulfuron applied in 1988

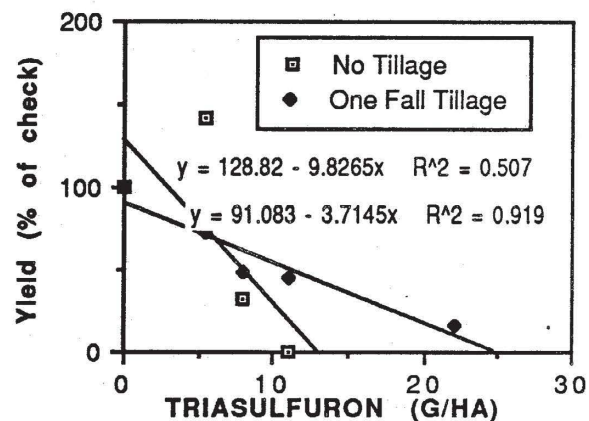
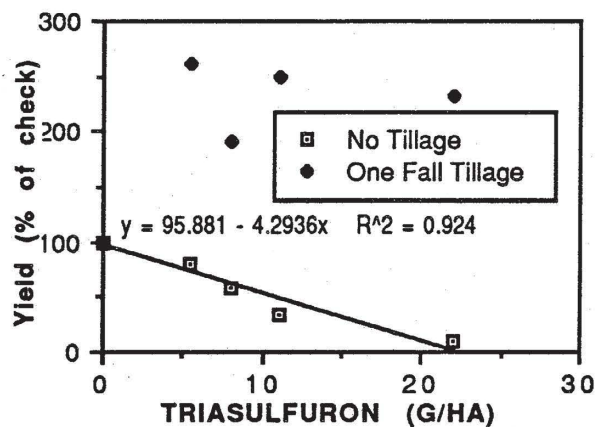


Figure 8. 1991 lentil yield response to triasulfuron applied in 1988

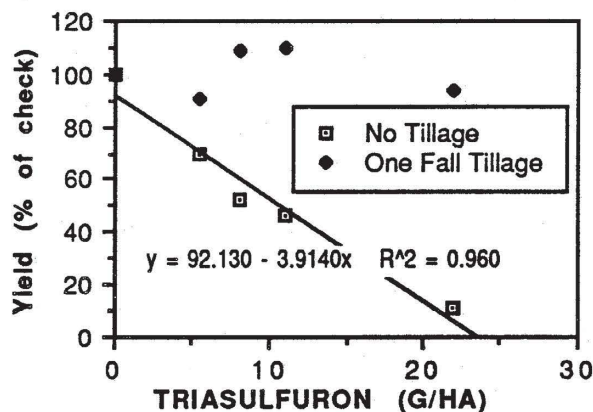


Figure 10. Weed population in untilled lentil plots June 1990

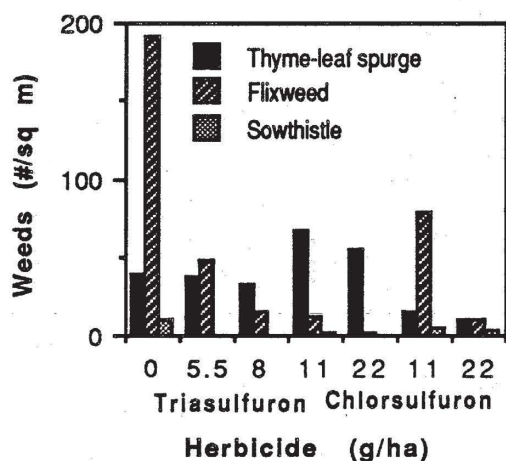
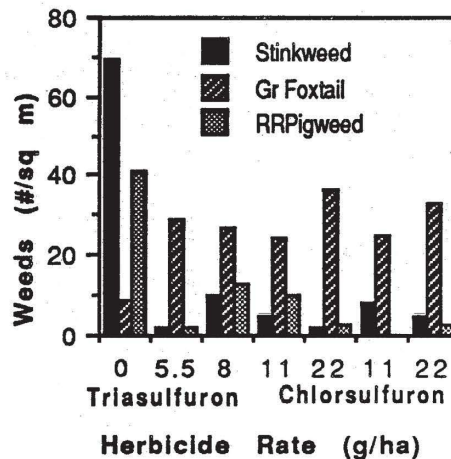


Figure 9. Weed population in tilled lentil plots June 1990



From these lines we calculated the relative potency of the herbicides under different tillage systems over time.

	Tillage Practice	
	No Tillage	One Fall Tillage
1989	11.3	no linear response
1990	6.6	12.2
1991	11.8	no response

In using this data to predict herbicide persistence one should bear in mind that this is a linear approximation of what could be a logistic or exponential relationship. It does however illustrate the fact that potency was generally decreasing with time and that it was decreasing more rapidly with tillage than without. In 1989 drought and weeds may have obscured the impact of the herbicide.

Figure 11. 1990 lentil Yield response to chlorsulfuron.

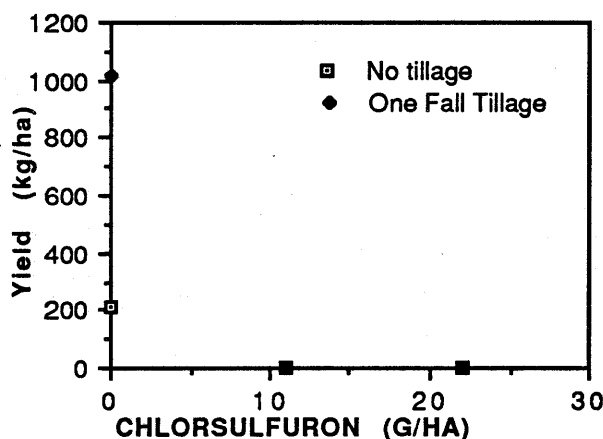
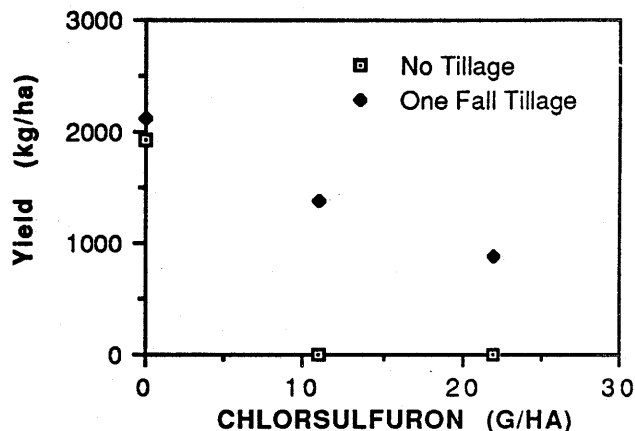


Figure 12. 1991 lentil yield response to chlorsulfuron.



Lentils were much more sensitive to chlorsulfuron than triasulfuron, even though the trend of decreasing yield with increasing herbicide rate and the relationship between tillage and herbicides were similar.

Although very dry conditions prevailed in the first two years of the study and grain yield was consequently quite variable, significant reductions in lentil yield occurred following the application of these two sulfonylurea herbicides. Injury was much greater in untilled plots compared to tilled. This affect may simply be a result of dilution caused by mixing the herbicide to a depth of 10 cm with tillage. Whatever the reason, producers, researchers and those involved in registering pesticides should be aware that tillage practices can significantly affect herbicide persistence and bioavailability.

Acknowledgements

This research was partially funded by Ciba Geigy Canada Ltd.

References

- Ferris, I.G., W.L. Felton, J.F. Holland and M.S.Bull. 1989. Effect of tillage practice on the persistence of atrazine in two contrasting soils in northern New South Wales. *Australian Journal of Experimental Agriculture* 29:948-53.
- Foley, M.E. 1985. Response differences of wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) to chlorsulfuron. *Weed Science* 34:17-21.
- Friesen, G.H. and D.A. Wall. 1991. Residual Effects of CGA-131036 and chlorsulfuron on spring sown rotational crops. *Weed Science* 39:280-283.
- Gunter P., A. Rahman and W. Pestemer. 1989. Quantitative bioassay for determining residues and availability to plants of sulfonylurea herbicides. *Weed Research* 29:141-146.
- Lafond, G.P, H.A. Loeppky and D.A. Derksen. 1991. Effects of tillage systems and crop rotation on soil water conservation, seedling establishment, and crop production of a thin black soil at Indian Head . *Proc. Soils and Crops Workshop, Saskatoon*. pp 478-489.
- Moyer, J.R., P. Bergen and G.C. Kozub. 1989. Chlorsulfuron persistence and response of legumes in an alkaline soil. *J. Environ. Sci. Health*. B24(1):37-56.
- Smith, A.E. and A.I. Hsiao. 1985. Transformation and persistence of chlorsulfuron in prairie field soils. *Weed Science*. 33:555-557.
- Sorenson B.A., P.J. Shea, and F.W. Roeth. 1991. Effects of tillage, application time and rate on metribuzin dissipation. *Weed Research* 31: 333-345.