Bioactivity and Dissipation of Pyroxasulfone Herbicide in Saskatchewan Soils

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Introduction

Because pyroxasulfone mode of action is distinctly different from the many herbicides to which weeds developed resistance, use of pyroxasulfone in rotation or in combination with other herbicides offers a new alternative in combating the weed resistance problems. Pyroxasulfone is a seedling shoot growth inhibitor, and is used for control of most annual grass and small seeded broadleaf weeds in wheat, corn and soybean. Pyroxasulfone is classified as group 15 herbicide by WSSA, as the primary target enzyme in weeds is a very long chain fatty acid elongase (Tanetani et al. 2009).

Limited information is available on pyroxasulfone behavior in western Canadian soils.

Objectives

The objectives were:
(1) to develop a plant bioassay for detection pyroxasulfone in soil,
(2) to examine pyroxasulfone bioactivity in soil,
(3) to assess pyroxasulfone dissipation is soil.

Materials and Methods

● Bioassay was performed in 2-oz WhirlPakTM bags (Szmigielski et al. 2008). Sugar beet (*Beta vulgaris* L. 'Beta 1385') was grown for 7 days.

● Five Saskatchewan soils were used for the study pyroxasulfone bioavailability and dissipation.

Table 1. Selected soil characteristics.

Soil (location)	Soil association	Organic carbon (%)	pH	Clay (%)
Central Butte1	Haverhill loam	1.3	7.9	16
Scott1	Scott loam	2.0	5.3	39
Central Butte2	Haverhill clay loam	2.2	7.2	26
Saskatoon	Sutherland clay	3.2	7.8	53
Scott2	Weyburn loam	3.2	6.2	22

(1) Development of a plant bioassay for detection of pyroxasulfone

Shoot and root length of sugar beet plants was measured in resoponse to soil-incorporated pyroxasulfone at 92 ppb after 4, 5, 6, 7 and 8 days of growth.

Results

Shoot length inhibition was more sensitive and more reproducible than root length inhibition (Fig. 1). Measuring shoot length inhibition of sugar beet after 7 days of growth was selected as suitable for detection of pyroxasulfone in soil.

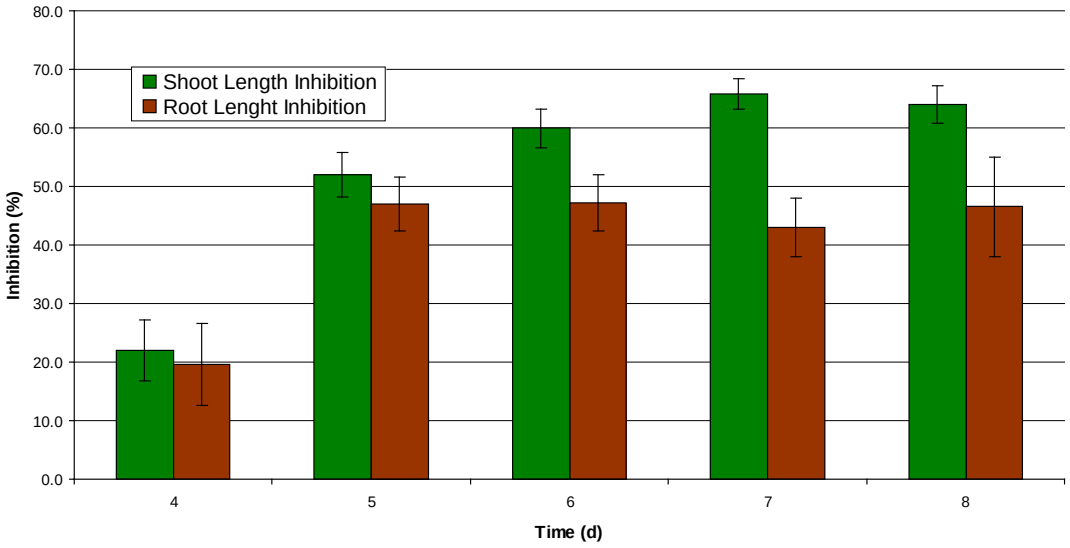

Fig. 1. Shoot and root length inhibition of sugar beet grown from 4 to 8 days in response to 92 ppb pyroxasulfone.

Fig. 2. A 7-d sugar beet biosassay performed in WhirlPakTM bags in the pyroxasulfone concentration range from 0 to 184 ppb.

(2) Pyroxasulfone bioactivity

Bioactivity was assessed by measuring sugar beet shoot response to increasing concentration of pyroxasulfone from 0 to 184 ppb. Plants were grown in the laboratory under fluorescent lights. GR50 values (concentration required for 50% length inhibition) for each soil were determined from the dose-response curves.

Results

The GR_{50} values ranged from 33 to 179 ppb (Fig. 3), and increased generally in the same order as percent organic carbon ($p = 0.001$, Table 2) thus indicating that pyroxasulfone adsorption to organic matter lowers pyroxasulfone bioactivity and may result in decreased pyroxasulfone efficacy.

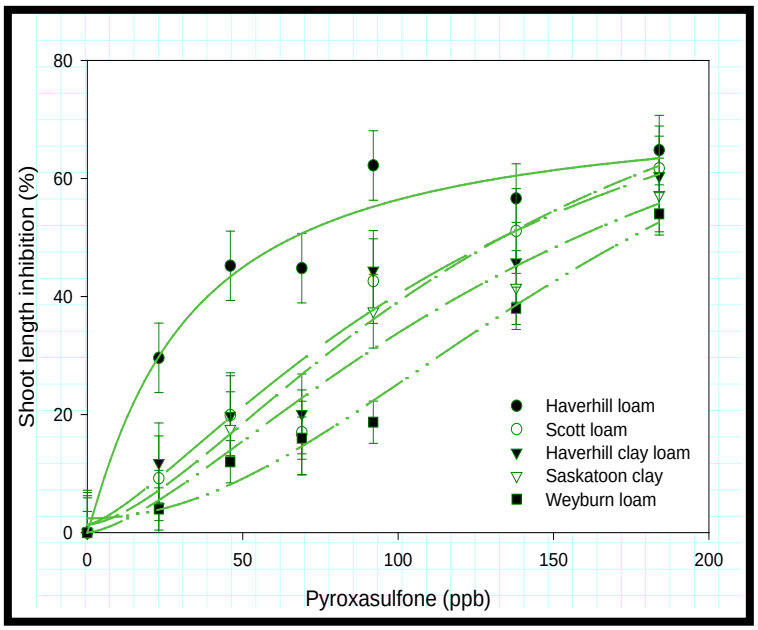

Fig. 3. Shoot length inhibition of sugar beet in response to increasing concentration of pyroxasulfone in five Saskatchewan soils.

Table 2. Multiple regression analysis for the GR_{50} values and selected soil characteristics.

Model	**Coefficient**	**Standard error**	**P value**
Intercept	63.8	79.9	0.441
% organic carbon	50.2	13.6	0.004
pH	-8.8	11.3	0.454
% clay	-0.7	0.9	0.433

(3) Pyroxasulfone dissipation

Dissipation was examined under laboratory conditions of 25 C and moisture content of 85% field capacity. Soil incubation was carried out for 16 weeks. Soils were sampled every two weeks and residual pyroxasulfone was determined using the sugar beet biossay. Half-lives were estimated from the dissipation curves.

Results

The dissipation half-lives varied from 16 to 69 days (Fig. 4), and were primarily related to soil pH ($p = 0.008$) and organic carbon content ($p = 0.034$, Table 3). Faster

pyroxasulfone dissipation occurred in soils of higher pH and higher organic carbon content probably due to conditions in which microbial decomposition is enhanced.

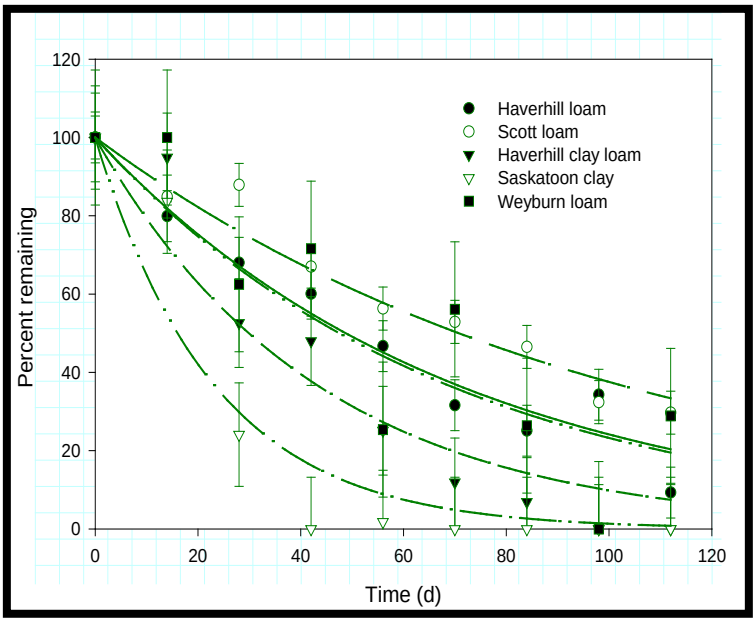

Fig. 4. Pyroxasulfone dissipation in five Saskatchewan soils under laboratory conditions of 25 C and moisture content of 85% field capacity.

Table 3. Multiple regression analysis for the dissipation half-lives and selected soil characteristics.

Model	**Coefficient**	**Standard error**	**P value**
Intercept	164.7	26.3	0.001
% organic carbon	-10.8	4.5	0.034
pH	-11.9	3.7	0.008
% clay	-0.4	0.3	0.196

References

Tanetani et al. 2009, Pestic. Biochem. Physiol. 95:47-55
Szmigielski et. al. 2006. Commun. Soil.Sci. Plant Anal. 39:413-420

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