Determination of Thiencarbazone in Soil by the Mustard Root Length Bioassay

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Introduction
Thiencarbazone is a new ALS-inhibiting herbicide available from Bayer CropScience. It controls certain broadleaf and grass weed species and has been registered for use in spring and durum wheat. Limited information is available on thiencarbazone detection and its behaviour in prairie soils.

Objectives
The objectives were (1) to investigate bioavailability and dissipation of thiencarbazone in soil using mustard root bioassay and (2) to examine the effect of N-fertilizer addition on root inhibition of mustard plants and consequently on the determination of thiencarbazone by the bioassay.

Materials and Methods
Thiencarbazone Bioavailability and Dissipation:
Five soils of varying properties were amended with thiencarbazone in the range from 0 to 3.846 ppb. The mustard root bioassay was performed in 2-oz. Whirl-PakTM bags (Fig. 1) and the root length was measured after three days of growth (Fig. 2). A log-logistic model was used to fit root length inhibition data from which the GR50 values were estimated.
Thiencarbazone dissipation study was carried out under laboratory conditions of 23 C and moisture content of 85% field capacity. Soils with added thiencarbazone at 3.846 ppb level were placed in the incubator and sampled every five days for up to 50 days. Half-lives were estimated from the dissipation curves.

Effect of N-fertilizer on mustard roots:
Ammonium nitrate was added to soil in the range from 0 to 400 ppm N (µg N per g of soil) and the bioassay was performed as described above. To examine the combined effect of thiencarbazone and N-fertilizer on mustard root growth, soil was supplemented with combinations consisting of 100 ppm N and increasing concentration of thiencarbazone.

Results and Discussion

Effect of soil properties on thiencarbazone bioavailability and dissipation:

Thiencarbazone bioavailability and dissipation were soil dependent. Bioavailability was lower in soils of high clay and organic matter content as evidenced by correlation of GR50 values with percent clay and organic carbon (Table 1). Thiencarbazone half-lives ranged from 5.0 to 31.6 days and increased with the increase of soil organic carbon (Table 1). Reduced bioavailability and slower dissipation are due to enhanced thiencarbazone adsorption to clay and organic matter surfaces that results in lower herbicide concentration in soil solution.

Effect of N-fertilizer on mustard roots:

Ammonium nitrate caused reduction of mustard root length (Fig. 3). Combined effect of ammonium nitrate and thiencarbazone on roots of mustard plants was additive as the observed and expected root length inhibition were similar (Fig. 4). The root reduction due to N-fertilizer may be misinterpreted as root reduction due to thiencarbazone or other ALS-inhibiting herbicides. Therefore knowledge of soil properties and soil treatments is necessary for correct interpretation of bioassay results.

Fig. 1. Mustard root bioassay in WhirlPak™ bags.

Fig. 2. Mustard root response to increasing concentration of thiencarbazone in soil.

Table 1. Selected soil properties, phytotoxicity GR_{50} values and dissipation half-lives for thiencarbazone in five Saskatchewan soils.

Soil (location)	Soil Association	pH	Organic carbon (%)	Clay (%)	GR_{50}[a] (ppb)	$t_{½}$[b] (days)
Central Butte (upper slope)	Haverhill	7.9	0.9	31	0.56	5.5
Central Butte (lower slope)	Haverhill	7.2	1.6	51	0.59	5.0
Clavet	Bradwell	7.1	1.5	26	0.60	17.6
Scott	Scott	5.3	2.3	39	0.62	13.2
Saskatoon	Sutherland	7.8	2.6	67	1.71	31.6
Corr GR_{50}[c]		0.366	0.637*	0.756*		
Corr $t_{½}$[d]		0.018	0.563*	0.302		

[a] GR_{50}, concentration corresponding to 50% inhibition,
[b] $t_{½}$, half-life,
[c] Corr GR_{50}, correlation between GR_{50} values and soil properties,
[d] Corr $t_{½}$, correlation between half-lives and soil properties.

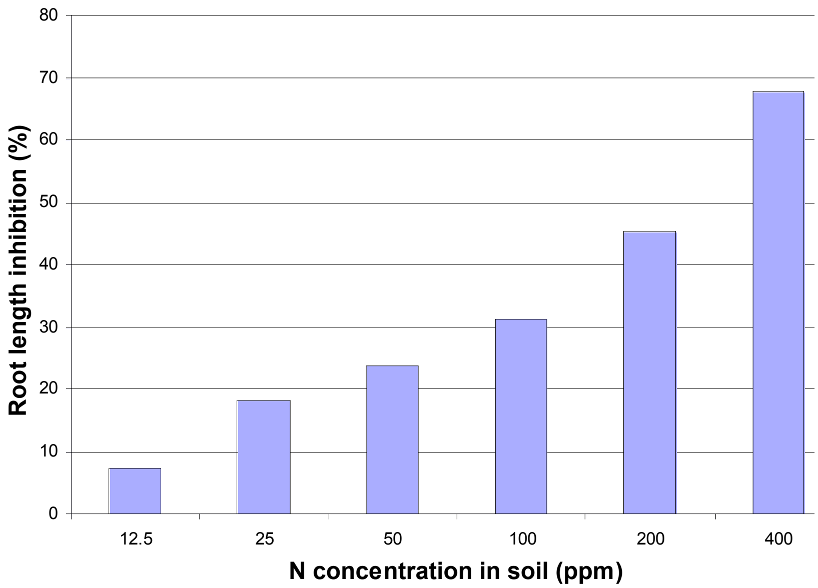

Fig. 3. Effect of increasing ammonium nitrate concentration in soil on root length inhibition of mustard plants.

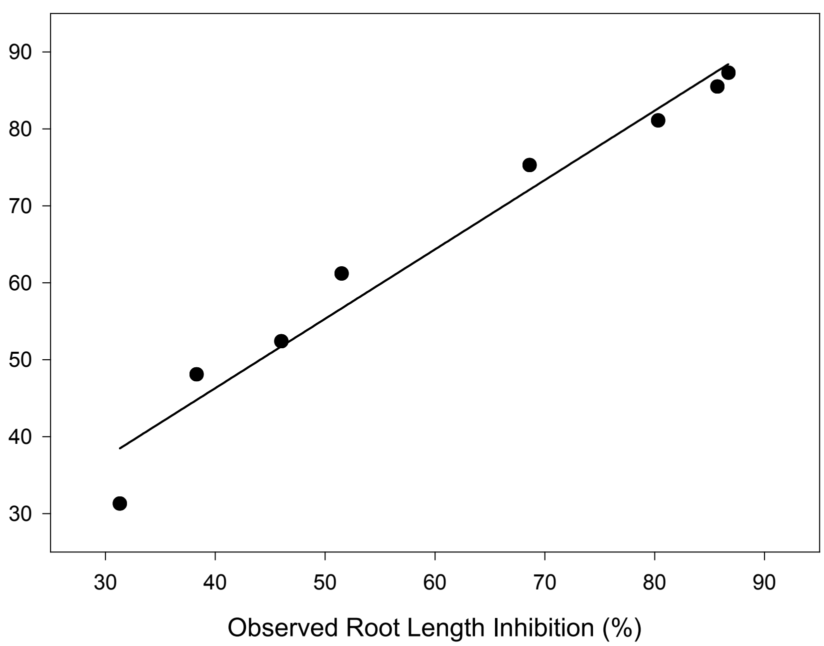

Fig. 4. Relationship between observed and expected root length inhibition of mustard plants in soil supplemented with 100 ppm N and with increasing concentration of thiencarbazone.

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Conclusions

High clay and high organic carbon content in soil will decrease thiencarbazone phytotoxicity and will increase thiencarbazone half-life. The recent addition of large amounts of N-fertilizer to soil may cause false positive results in soils bioassayed for thiencarbazone or other ALS-inhibiting herbicide residues using the mustard root length inhibition technique.

References

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