Application of a Mustard Root Bioassy to Assess Phytotoxicity of Group 2 Herbicides

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Abstract

Group 2 herbicides exhibit high bioactivity at low concentrations in soil and may persist into the next growing season causing crop injury. A bioassay that is suitable for the detection of a range of Group 2 herbicides was developed; in this bioassay, a root growth inhibition of oriental mustard is used for the determination of the herbicide concentration in soil. The Group 2 herbicides included were: Everest (flucarbazone-sodium), Frontline (florasulam), Sundance (sulfosulfuron), and Odyssey (imazamox + imazethapyr). This bioassay was used to examine the degree of root inhibition by simultaneous application of two Group 2 herbicides. Application of varying levels of flucarbazone or sulfosulfuron combined with Odyssey resulted in root length inhibition that was comparable to the root length inhibition caused by application of flucarbazone alone or sulfosulfuron alone and Odyssey alone, possibly indicating an additive effect of these pairs of herbicides. Further studies are needed to examine which combinations of Group 2 herbicides under what environmental and soil conditions may result in "stacking" causing increased plant injury.

Introduction

Advantages of Group 2 herbicides include low use rates, broad spectrum weed control and low mammalian toxicity. These characteristics have made Group 2 herbicides an important part of production agriculture since their discovery in the mid 1970's. However, Group 2 herbicides often persist in soil and may cause damage to subsequent crops in rotation.

Methods for the detection of residual Group 2 herbicides in soil are needed in order to make better re-cropping decisions. Chemical methods are usually costly, time consuming and may not be sensitive enough for the determination of ppb residual herbicide levels. Bioassays are generally more sensitive and simple but may lack specificity and the results may vary with soil type and plant species.

The objectives of this study were (1) to select a plant bioassay that would be suitable for the detection of a range of Group 2 herbicides in soil, and (2) to examine, using the bioassay, if a simultaneous application of two Group 2 herbicides will have an additive effect on plant injury.

Materials and Methods

Herbicides:

The following Group 2 herbicides were investigated: Everest (flucarbazone-sodium), Frontline (florasulam), Sundance (sulfosulfuron) and Odyssey (imazamox + imazethapyr). Pure compounds were used for Everest, Frontline and Sundance while commercial formulation was used for Odyssey.

Soil Spiking:

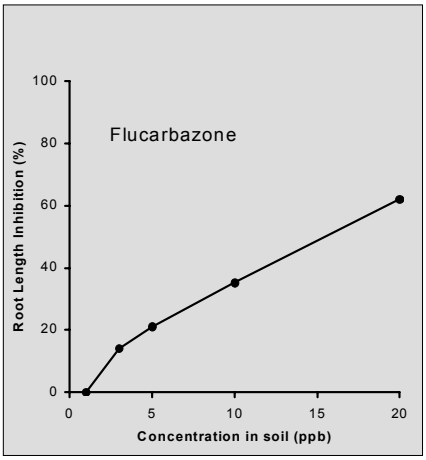
Solutions of each herbicide were prepared in such a way that the highest concentration represented the field application rate recommended by the manufacturer. Soil samples (75 g) were spiked with each herbicide or combinations of two herbicides by uniformly mixing a calculated amount of herbicide solution in a volume of water equivalent to 100% field capacity with soil.

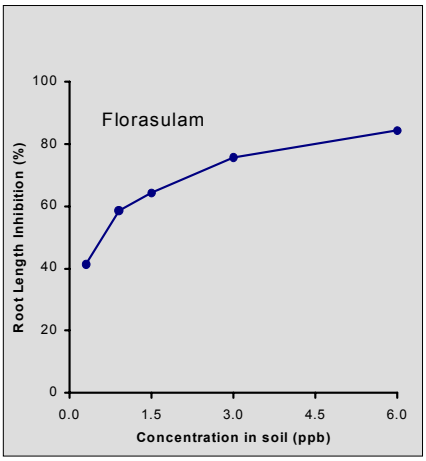
Mustard Root Bioassay:

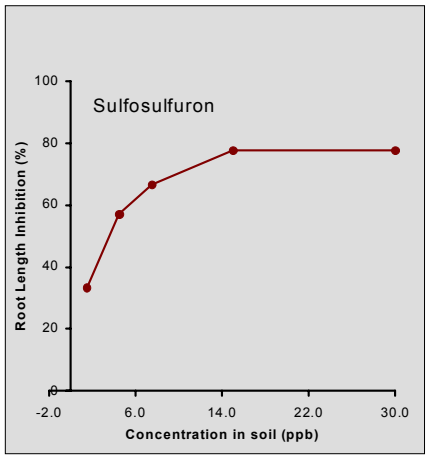
Bioassay consisted of seeding five pregerminated oriental mustard seeds (*Brassica juncea*) in Styrofoam cups containing spiked soil and growing the seedlings for five days under florescent light. Soils were watered daily to 100% field capacity. After five days of growth, plants were removed from soil and root length was measured. Root length inhibition was calculated using the formula RLI = $(1-(L_t/L_0))*100\%$ where L_t is the length of the treated root and L_0 is the length of the untreated root.

Results and Discussion

Oriental mustard was found to be a suitable crop for the detection of the investigated Group 2 herbicides (Figure 2). Florasulam and sulfosulfuron were considerably more toxic to the root development of mustard plants than flucarbazone and Odyssey (Figure 2).







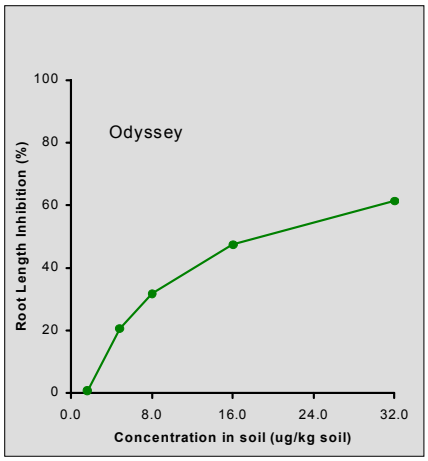
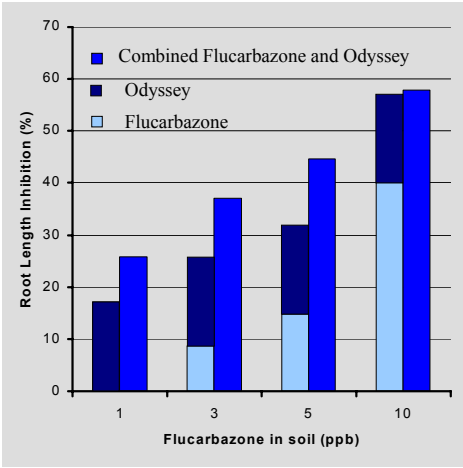


Figure 2. Plant response curves for root length inhibition of oriental mustard grown in a soil spiked with different Group 2 herbicides under laboratory conditions at 25°C.

Application of varying levels of flucarbazone or sulfosulfuron combined with Odyssey resulted in root length inhibition that was comparable to the root length inhibition caused by application of flucarbazone alone or sulfosulfuron alone and Odyssey alone, possibly indicating a additive effect of these pairs of herbicides (Figure 3).



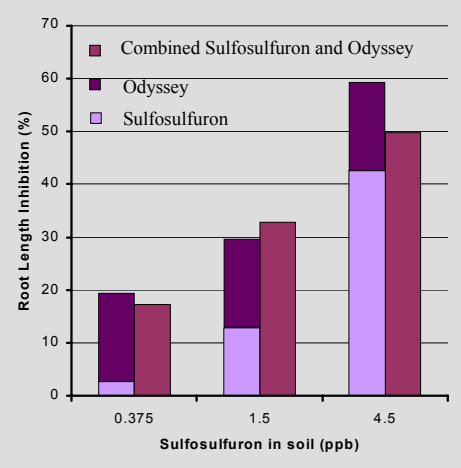


Figure 3. Effect of individual herbicides and their combinations on root development of oriental mustard.

Conclusions

A bioassay using oriental mustard root length inhibition is suitable for sensitive and accurate measurements of Group 2 herbicides. Simultaneous application of two Group 2 herbicides may have an additive effect on plant injury as observed for flucarbazone and Odyssey and sulfosulfuron and Odyssey. Further studies are needed to examine which combinations of herbicides under what environmental and soil conditions may result in "stacking" causing increased plant injury.

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