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The Effect of Prometryn Soil Residue on Soil Microbial Biomass and Different Crops Biomass

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ABSTRACT

The environmental risk of herbicides should be evaluated near sites of use, even though basic ecotoxicological tests have been conducted before any herbicide can be registered for marketing. For example, for triazine herbicides, which are photosynthetic PSII herbicide and considered only slightly or moderately toxic to many susceptible plants, soil microorganisms, mammals and humans, concerns have arisen as these herbicide are members of a class claimed to be carcinogenic, or may affect the development of reproductive toxins. For this reason, more reliable evidence is needed to test these claims and investigate their ecological effects. Prometryn is one of triazine herbicides that may leave residual activity in the soil for extended periods, causing injury and yield reduction of crops in rotation like bean. A pot experiment was conducted under greenhouse conditions in order to study the sensitivity of 4 different crops (lettuce, barley, rapeseed and beet) to prometryn soil residue (0.0033, 0.0166, 0.033, 0.066, 0.1 and 0.166 mg. kg^{-1} soil) in Iran, in 2014. The plants were thinned to five plants per pot after germination. The pots were kept for 30 days under controlled conditions. Shoot and root biomass production was measured 30 days after emergence. Results showed that the shoot and root dry matter were significantly affected by increasing prometryn soil residue in all crops ($p<0.01$), but seed emergence was not affected. Crops showed different responses to prometryn soil residues. Based on ED50 parameter rapeseed (0.0137 mg kg^{-1}soil) and barley (0.0282 mg kg^{-1}soil) appeared the most sensitive and tolerant crops to prometryn soil residue, respectively. The other crop sensitivity to prometryn soil residue followed as: rapeseed>lettuce>beet>barely. Based on the mechanism of action of prometryn and its best efficiency on board leaf plants control, the least biomass reduction obtained for barley is understandable. In general, this is safe to plant a susceptible species if the plant-available residue were less than the species ED10 value, and there would be a great risk for different levels of crop damage if the plant-available residue were higher than ED50 values of the species.

TABLE AND FIGURE

Table 1- Effect of Prometryn residues on crops root and shoot dry matter

Crop	Prometryn (mg. kg^{-1}soil)	Shoot dry matter	Root dry matter
Rapeseed	0	0.190^{gh}	0.090^{def}
	0.0033	0.140^{hi}	0.066^{defg}
	0.0166	0.093^{ijk}	0.030^{fg}
	0.033	0.043^{kl}	0.011^{fg}
	0.066	0.006^{l}	0^{g}
	0.1	0^{l}	0^{g}
	0.166	0^{l}	0^{g}
Beet	0	0.320^{d}	0.123^{cde}
	0.0033	0.266^{e}	0.083^{defg}
	0.0166	0.186^{gh}	0.043^{efg}
	0.033	0.103^{ij}	0.013^{fg}
	0.066	0.020^{l}	0^{g}
	0.1	0^{l}	0^{g}
	0.166	0^{l}	0^{g}
Lettuce	0	0.423^{c}	0.200^{bc}
	0.0033	0.340^{d}	0.133^{cd}
	0.0166	0.253^{ef}	0.086^{defg}
	0.033	0.090^{ijk}	0.023^{fg}
	0.066	0.018^{l}	0^{g}
	0.1	0^{l}	0^{g}
	0.166	0^{l}	0^{g}
Barely	0	0.556^{a}	0.316^{a}
	0.0033	0.480^{b}	0.256^{ab}
	0.0166	0.423^{c}	0.180^{bc}
	0.033	0.206^{fg}	0.086^{defg}
	0.066	0.080^{jk}	0.006^{fg}
	0.1	0^{l}	0^{g}
	0.166	0^{l}	0^{g}

Values followed by the same letter are not significantly different (P<0.05) according to Duncan's multiple range test.

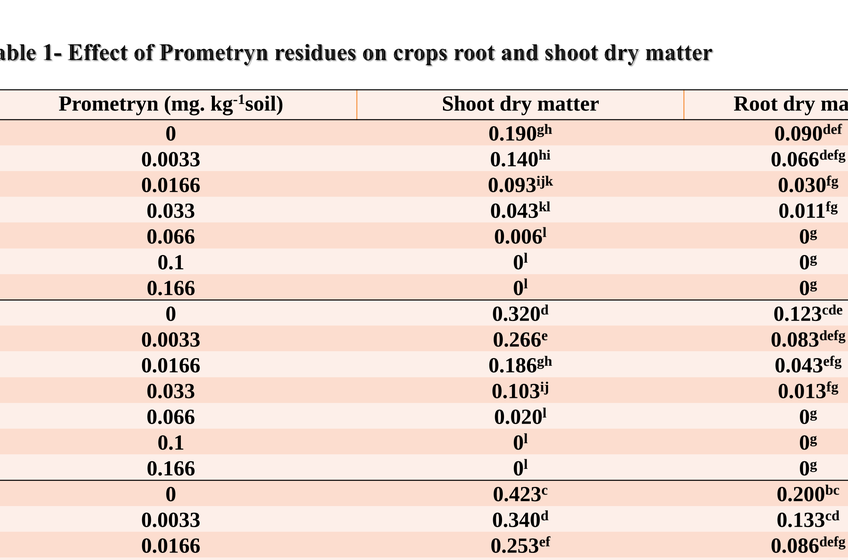

Figure 1- Shoot dry matter response to prometryn soil residual

MATERIALS AND METHODS

- A pot experiment was conducted under greenhouse conditions in order to study the sensitivity of 4 different crops to prometryn soil residue at the College of Agricultural Sciences, Ilam University, Ilam, Iran in 2014. Experimental type was completely randomized design in a factorial arrangement with three replications. Treatments included 4 different crops (lettuce, barley, rapeseed and beet) and prometryn simulated concentrations residues in soil (0.0033, 0.0166, 0.033, 0.066, 0.1 and 0.166 mg. kg^{-1}soil). 15 cm diameter pots were filled with a modified soil and 10 of seeds of crops were planted in 5 regular positions. The plants were thinned to five plants per pot after germination. The pots were kept for 30 days under controlled conditions. Shoot and root biomass production was measured 30 days after emergence.
- At harvest, growth parameters including the dry weight of shoots and roots were determined. The data were subjected to analysis of variance by using Mstatc software. Plant response to prometryn residues was fitted with sigmoidal 3 and 4 parametric equations to the shoot biomass data as a function of the herbicide residue concentrations and was used to calculate the doses for 50% inhibition of shoot growth (ED_{50}). In another experiment the effect of prometryn concentrations (0, 0.0033, 0.0166, 0.033, 0.066, 0.1 and 0.166 mg. kg^{-1}soil) on soil microbial activity was determined using titration method in controlled conditions.

RESULTS AND DISCUSSION

•Plant response to increasing concentration of prometryn, in general, followed a classical dose response relationship. The logistic model fitted well to the root and shoot plants response herbicide concentrations. Results showed that the shoot and root dry matter were significantly affected by increasing prometryn soil residue in all crops ($p<0.01$), but seed emergence was not affected. Crops showed different responses to prometryn soil residues. Based on ED_{50} parameter rapeseed (0.0137 mg kg^{-1}soil) and barley (0.0282 mg kg^{-1}soil) appeared the most sensitive and tolerant crops to prometryn soil residue, respectively. The other crop sensitivity to prometryn soil residue followed as: rapeseed>lettuce>beet>barely. Based on the mechanism of action of prometryn and its best efficiency on board leaf plants control, the least biomass reduction obtained for barley is understandable. In general, this is safe to plant a susceptible species if the plant-available residue were less than the species ED_{10} value, and there would be a great risk for a different levels of crop damage if the plant-available residue were higher than ED_{50} values of the species. Comparisons between species allow the safe selection of a crop that has a critical ED_{50} level lower than the residue level in the soil. Alternatively, planting a sensitive species could be delayed until the residue level in the soil is less than the critical level. In the Southwest areas of Iran, these crops are often sown few months after the application of a residual herbicide in the preceding crop. This large variation in plant sensitivity to prometryn residues indicates that there is potential for considerable damage to some of the rotational crops. In second experiment the results clearly indicating that in initial days application of prometryn used drastically reduced the C, N and total microbial in treated soil compared with the untreated (Control) soil.

CONCLUSIONS

- From the results of the study, it is concluded that these crops are very suitable for use in bioassays for the side-effects of prometryn at low concentration rates. In this study prometryn herbicide provided symptoms of phytotoxicity to crops were studied, whereas crops seed germination was not adversely affected. In the other hand, this condition indicating that the application of prometryn in agricultural soil leads to decrease the total biomass of soil microorganisms at initial period. By possibly knowing the level of prometryn residual in the soil, producers could have some flexibility in crop rotations if sensitive crops such as rapeseed are to be planted following triazine herbicide use on crops.